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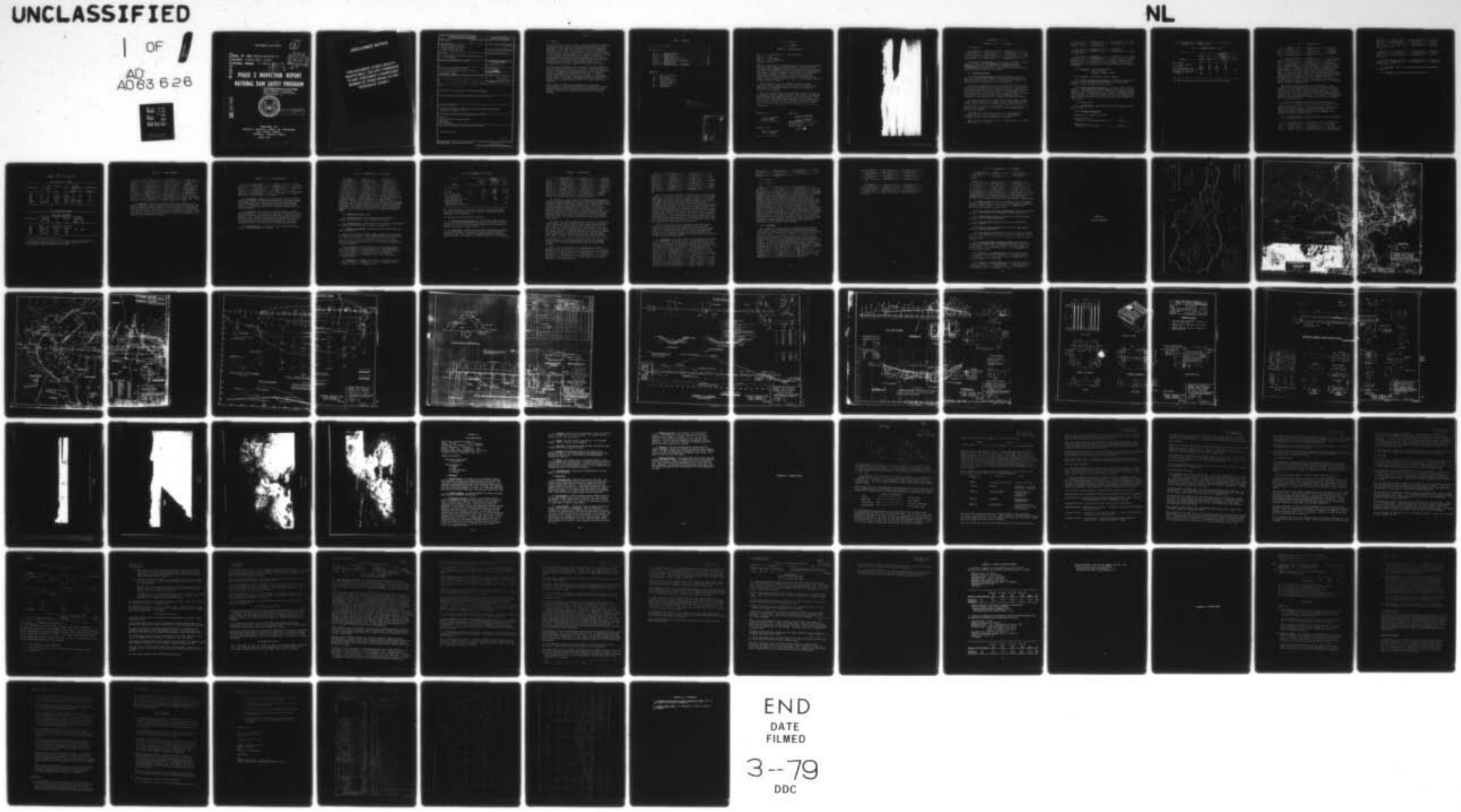

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RAPPAHANNOCK RIVER BASIN

Name Of Dam: MOUNTAIN RUN DAM NO. 18
Location: CULPEPER COUNTY, VIRGINIA
Inventory Number: VA 04706

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

U.S. ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT

PREPARED BY
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

AUGUST 1978

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

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MOUNTAIN RUN NO. 18

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Mountain Run No. 18 Dam #VA 04706
State: Virginia
County: Culpeper County
USGS Quad Sheet: Culpeper West
Stream: Balls Run

Mountain Run No. 18 is an earthfill structure 1,000 feet long and 38.5 feet high. The principal spillway consists of a drop inlet to a 30-inch diameter reinforced concrete pipe running through the dam at a low level. The emergency spillway is a 150-foot wide vegetated earth side channel spillway. The dam is located on Balls Run about 3/4 miles north of Culpeper, Virginia. The dam was designed and constructed under the supervision of the U. S. Soil Conservation Service and is presently owned by Mr. John H. Harlow, Route 1, Box 18, Culpeper, Virginia 22701.

The spillway will pass the Probable Maximum Flood (PMF). Therefore, based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway is considered to be adequate.

The visual inspection revealed no apparent problems and there are no immediate needs for remedial measures. The slopes of the dam meet the requirement recommended by the U. S. Bureau of Reclamation for zoned earthfill dams. The actual embankment structure appears to be similar to the "as-built" drawings. The dam is adequate for normal pool operation, but the check on slope stability under the full loading conditions cannot be made without construction records and calculations.

Submitted by:

Original signed by
JAMES A. WALSH

Recommended by:

Original signed by
ZANE M. GOODWIN

Approved:

Original signed by
Douglas L. Haller

DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

AUG 31 1978

CREST OF EMBANKMENT

MOUNTAIN RUN NO. 18

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (See Reference 1, Appendix VII). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Mountain Run Dam No. 18 is an earth-fill structure about 1,000 feet long and 38.5 feet high. The top of the dam is 14 feet wide and is at elevation 397.2 feet m.s.l. Side slopes are 2.5 horizontal to 1 vertical (2.5:1).

The principal spillway consists of a 30-inch diameter reinforced concrete pipe, running through the dam at a low level. This pipe is served by a drop-inlet structure (riser) located in a low elevation of the reservoir just upstream from the heel of the embankment. The crest of the riser is at elevation 376.5. A concrete outlet structure is provided at the downstream end of the principal spillway so discharges will not jeopardize the structural integrity of the dam.

The emergency spillway is a vegetated earth side-channel spillway located off the north end of the dam. It has a bottom width of about 150 feet with a crest at elevation 388.5 and side slopes of 3:1. Selected topsoil is placed in 4" thicknesses on the side slopes and on the bottom of the spillway. The topsoil is well compacted on the bottom of the spillway.

A 30-inch gated inlet with invert at a low level enters the upstream side of the riser from the reservoir. This permits withdrawal of water from the bottom of the reservoir.

There are no facilities for withdrawal of water from the reservoir for water supply at this time.

1.2.2 Location: Mountain Run Dam No. 18 is located on Balls Run about 3/4 mile upstream from Culpeper, Va. The reservoir formed by the dam is known locally as Ball Run.

1.2.3 Size Classification: The dam is classified as an "intermediate" size structure because of its maximum storage potential of 2,290 acre-feet.

1.2.4 Hazard Classification: The dam is located in an urban area and is therefore given a high hazard classification in accordance with guidelines contained in Section 2.1.2 of Reference 1, Appendix VII. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: Mr. Charles H. Harlow
Route 1, Box 18
Culpeper, Virginia 22701

1.2.6 Purpose: Flood Control and water supply.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of the U.S. Soil Conservation Service. Construction was completed in 1973.

1.2.8 Normal Operational Procedures: Operation of the project is automatic. The principal spillway is ungated, therefore water rising above the crest of the drop inlet is automatically passed downstream. Similarly water is automatically passed through the emergency spillway in the event of an extreme flood which fills the flood storage space. Water is withdrawn from the conservation storage space as needed for water supply.

1.3 Pertinent Data:

1.3.1 Drainage Areas: The dam controls a drainage area of 3.99 square miles.

1.3.2 Discharge at Dam Site:

Maximum flood at dam site not known.

Principal Spillway:
Pool level at emergency spillway crest . . . . 108 c.f.s.

Emergency Spillway:
Pool level at top of dam . . . . 12,340 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet m.s.l.	Reservoir Area acres	Reservoir Capacity Acre feet	Reservoir Capacity Watershed inches	Reservoir Length miles
Top of dam	397.2	185	2290	10.8	-
Maximum pool, design surcharge	391.1	136	1298	6.1	-
Emergency spillway crest	388.5	120	967	4.5	-
Principal Spillway crest (a)	376.5	46	270	1.3	0.4
Streambed at centerline of dam	359±	0	0	0	0

(a) Top of conservation pool and bottom of flood control pool.

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of the U.S. Soil Conservation Service. As-built drawings and complete design data are available in the office of the State Conservationist, U.S. Soil Conservation Service, P.O. Box 10026, (Federal Building, Room 9201) Richmond, Va. 23240.

A geologic (foundation) investigation was conducted at the site by the SCS during the initial design stages. The investigation included drilling 11 core borings and excavating 87 test pits along the proposed dam alignment, principal and emergency spillways and borrows areas. The core borings were drilled into rock and pressure tested where possible. Multiple constant head field permeability tests were also conducted in most of the holes in addition to the pressure tests. The test pits were excavated with an industrial tractor to a depth of 11 feet or refusal on rock. Geologic logs and profiles were prepared from the borings and test pits. A detailed geologic report with foundation recommendations was also prepared based on the borings, test pits and field tests. The profiles are shown as "as built" drawings on plates III, IV, and VI of Appendix I. The geologic report is inclosed as Appendix IV.

Referring to Plate IV, Appendix I, the embankment structure consists of a zoned compacted earth dam with a 12 ft. bottom width cutoff trench of variable depth extending into bedrock. The cutoff trench and the inner core consist of mostly ML and some CL materials. The outer shell of the dam consists of SM and some SM-ML material. A summary of the engineering properties of the foundation and embankment materials determined by the Soil Conservation Service (see Appendix VI) is given in Table 2.1.

To control the phreatic surface and to collect seepages, a drainage system is located under the downstream portion of the dam. The drainage system consists of a trench 4 feet wide filled with graded filter material and a 6 inch perforated pipe. Depth of the trench is variable as indicated on Plate III, Appendix I. An interceptive drain of similar construction runs parallel to the principal spillway to the plunge pool.

The emergency spillway, located at the left abutment, is formed by a cut into non plastic SM material.

The slope stability was checked with the modified Swedish circle and the sliding block methods. The conditions assumed for the analyses are given in Section 6 and Appendix V. Only one trial analysis was made using each method for the upstream slope and for the downstream slope. The sliding block method showed the lower factor of

safety for both slopes. With full drawdown condition, the factor of safety for the upstream slope is 2.25. The factor of safety for the downstream slope is 2.27 for the full steady seepage condition with drain located at c/b = 0.6. Computations for the stability analyses were not available.

No information on settlement analysis was available, except for a recommendation of an overfill of 0.6 foot for the embankment structure across the floodplain to compensate for foundation and embankment settlement.

2.2 Construction: The construction records were not furnished by the SCS office in Richmond, but they are available from the SCS office in Washington, D. C.

2.3 Operation: There is no known operation and instrumentation procedure.

2.4 Evaluation: See Evaluation given in Section 6.3.

Table 2.1
SUMMARY OF SOIL ENGINEERING DATA

(A) FOUNDATION MATERIAL

Classification	Consistency Limits		Dry Unit Wt.	Water Content	Strength Parameters		Compressibility
	LL %	PI %	pcf	%	Ø degree	C psf	ft./ft.
MH	59	19	62.4	49.8	-	-	-
ML	35-39	9	84.2-94.2	4.0-7.0	21*	300*	.05
SC	26	12	117.0	8.5	-	-	-
CL	37	14	99.2	25.9	20.5*	1250*	.01
SP-SM	nonplastic		93.0	16.0	34.5+	1000+	-

(B) EMBANKMENT MATERIAL

Classification	Consistency Limits		Compaction Properties Dry Unit Wt.	Compaction Properties Opt. Water Content	Strength Parameters	
	LL %	PI %	pcf	%	Ø degree	C psf
MH	59-63	26	88.0-92.5	27.0-32.5	-	-
ML	22-40	3-7	98.5-111.0	14.5-22.5	-	-
**ML	nonplastic		95.8	20.5	30	800
CL	28	12	115.5	14.5	-	-
SM	nonplastic		114.0	13.5	-	-

* Consolidated Undrained triaxial test
\+ Direct shear test (conditions for consolidation and drainage not given)
** Consolidated Undrained triaxial test on sample compacted to 95% at optimum moisture content and soaked for seven days.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: Field observation are outlined in Appendix III. There is excessive growth of vegetation on portions of the embankment, right abutment, at the toe of the dam and within the riprap in the discharge channel. However, an area on the upstream embankment as outlined in Appendix III and noted in 1978 SCS annual inspection report, is thinly vegetated. Several animal burrows were noted in the embankment. Also, the upstream embankment at pool elevation has experienced erosion. This erosion has also been recorded in the 1978 SCS inspection report and is outlined in Appendix III. An unimproved road traverses the emergency spillway and the crest of the dam. Colloidal sediment was evident in foundation drain pipes. The dam had no staff gages or instrumentation. There was no access to the riser. Manual controls were not available to test intake valves in the riser.

3.2 Evaluation: Overall, the structure was in good condition at the time of inspection. However some minor remedial measures are required. All types of vegetation that have extensive root system should be cleared from the faces and toe of dam and from the ripraps. The crest of the dam should be closed to vehicular traffic and the bare spots should be reseeded. In the event that the traffic cannot be successfully controlled, the crest must be protected from erosion with a pavement.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Operation of the project is automatic. The 30-inch diameter principal spillway is ungated, therefore water rising above the crest of the drop inlet is automatically passed downstream. This in turn automatically maintains the pool level at or near elevation 377 ft. MSL most of the time. Water is automatically passed through the ungated emergency spillway in the event of an extreme flood which fills the flood storage space.

4.2 Maintenance: Maintenance of the project consists mainly of fertilizing, liming, and mowing the embankment and spillway; seeding and mulching bare areas; painting the trash racks; and repairing gullies that might occur. Maintenance of the downstream channel consists of controlling vegetation and removing any debris, bars or other obstructions.

4.3 Inspection: The project is inspected annually to insure proper maintenance. The inspection of the dam is conducted as part of the Annual Inspection of the works of improvement in the Mountain Run Watershed. The inspection team consists of representatives from the town of Culpeper, the U.S. Soil Conservation Service, the Virginia Soil Water Conservation Commission, the Culpeper Soil and Water Conservation District and the Mountain Run Watershed Association.

4.4 Warning System: At the present time, there is no warning system or evacuation plan in operation.

SECTION 5 - HYDRAULIC/HYDROLOGIC DESIGN

5.1 Design: The elevation of the crest (376.5 feet m.s.l.) of the drop inlet to the principal spillway was established at an elevation which would provide the conservation storage needed for sediment deposit and water supply. The capacity (108 c.f.s. with reservoir level at crest of emergency spillway) of the principal spillway was established by consideration of a number of factors including (1) the capability of evacuating the flood storage space within a reasonable time (± 10 days), (2) not passing damaging flows downstream, and (3) the capability of the reservoir to store flood waters. The crest (elevation 388.5) of the emergency spillway was established at the maximum elevation reached in routing the principal spillway hydrograph which resulted from the 100-year 10-day rainstorm. The elevation of the top of the dam (elevation 397.2) was established by the maximum elevation reached in passing the freeboard hydrograph. The freeboard hydrograph is that computed from rainfall comparable to the Probable Maximum Rainfall as used by the Corps of Engineers and is therefore comparable to the Probable Maximum Flood (PMF).

5.2 Hydrologic Records: None

5.3 Flood Experience: Flooding during Hurricane Agnes in Culpeper in June 1972 was reduced somewhat by this dam.

5.4 Flood Potential: Design features of the dam were established by routing various hydrographs as noted in paragraph 5.1.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1.

Except for withdrawal for water supply, regulation of flow from the reservoir is automatic. Water rising above the crest of the drop inlet flows into this inlet and through the dam in the 30-inch concrete conduit. Water also flows past the dam over the ungated emergency spillway in the event water in the reservoir rises over the crest of the spillway.

Outlet discharge capacity, reservoir area and storage capacity data, and hydrograph and routing determinations were obtained from reports and computations furnished by the Soil Conservation Service (SCS). The routing of the emergency spillway and freeboard hydrographs began with the reservoir level at the crest of the principal spillway.

5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on reservoir performance in various hydrographs is shown in the following table:

Table 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrograph: Principal Spillway (a)	Hydrograph: Emergency Spillway	Hydrograph: Free-Board (b)
Peak flow, c.f.s.				
Inflow	2	N/A	7,280	24,400
Outflow	2	108	1,580	12,340
Peak elev., ft. msl	376.5	388.5	391.1	397.2
Emergency Spillway				
Depth of flow, ft.	-	0	2.6	8.7
Avg. velocity, f.p.s.(c)	-	0	3.9	8.1
Non-overflow section				
Depth of flow, ft.	-	-	-	0
Avg. velocity, f.p.s.(c)	-	-	-	-

(a) 100-year 10-day volume produces the most conservatively large indication of flood control storage required. Detailed discharge hydrograph was not determined.

(b) Probable maximum flood by COE standards.

5.7 Reservoir Emptying Potential: The 30-inch conduit through the dam at a low level will permit withdrawal of about 108 c.f.s. with the reservoir level at the emergency spillway crest and essentially dewater the reservoir in about 1 week.

5.8 Evaluation: Hydrologic and hydraulic determinations prepared by the SCS as a basis for design of the project appear reasonable. The spillway will pass a freeboard hydrograph which is essentially equal to the PMF. The spillway is therefore considered to be adequate.

SECTION 6 - DAM STABILITY

6.1 Foundation: Mountain Run Dam No. 18 is founded on alluvial, terrace and residual soils overlying weathered igneous and metamorphic bedrock. A 12-foot wide (base) cutoff or core trench keys the earth embankment into weathered bedrock. A seepage drain, 4 feet wide, runs approximately 660 feet along the length of the dam 66 feet downstream of the centerline. The drain system is founded on weathered bedrock and varies in thickness according to local foundation conditions. "As built" drawings of the cutoff trench and seepage drain on a geologic profile are shown on plates III and VI respectively in Appendix I. The remainder of this section deals with describing the geologic location of the dam site and the foundation conditions.

The dam site is located within the Piedmont Plateau Physiographic Province of Virginia which is underlain by predominately igneous and metamorphic rocks of Precambian to Cambian age. A narrow band of much younger sedimentary rocks comprising the Triassic Basin trends northeast-southwest through much of the Piedmont. A section of the basin cuts through the Culpeper area. The contact between the sedimentary rocks of the basin and the older metamorphic rocks to the west is a border thrust fault that intersects the City of Culpeper. Subsequent thrust and transverse faulting which occurred along the border area after the basin's formation has greatly complicated the local geology.

The dam site is located approximately one mile west of the basin contact and is underlain by only the older igneous and metamorphic rocks. The Triassic basin sediments occur just downstream of the dam. Syenite, an igneous plutonic rock, underlies most of the dam site but is overlain by the metamorphic rocks under the left abutment and channel section. The syenite, however, does comprise the entire steeper right abutment except for the soil cap. The metamorphic rocks, which are part of the Lynchburg Formation include phyllite, meta-arkose, and slate. The phyllite and slate underlie most of the left abutment above the syenite. Meta-arkose underlies most of the channel section. In addition, amphybolite dikes occur randomly throughout the foundation bedrock except under the steeper right abutment.

Soils overlie all the bedrock and comprise the foundation-embankment contact. From 4 to 11 feet of alluvial and terrace soils overlie residual soils and the weathered phyllite and slate along the left abutment. From 10 to 13 feet of coarser grained alluvial soils directly overlie the weathered meta-arkose along the channel section and approximately 5 feet of residual soils overlie the weathered syenite along the right abutment.

The structural relationship between the various rock types is fairly complex. Jointing and minor Triassic normal faulting occur within the bedrock. No prominent joint system however, was noted. The faulting occurs perdominately at the contact of the syenite and softer meta-arkose and phylitte, but little fault gouge or brecciated material was encountered. However, running sands were noted in a fault zone at the toe of the right abutment where the syenite contacts meta-arkose. The amphybolite dikes intrude the other rocks in zones that strike nearly parallel to the dam alignment. The schistosity of the metamorphic rocks strikes N42° to 47°E and dips 35° to 48° SE.

The condition of the foundation materials varies according to the composition. The soils are relatively soft or loose near the surface and become harder or more dense with depth as expected. The alluvial soils under the channel section are especially dense. Fairly dense and impermeable residual soils overly the weathered bedrock throughout. The weathered rock proved fairly impermeable during field testing except at one fault zone previously mentioned and within some badly fractured meta-arkose near the toe of the left abutment. The geology report recommended the cutoff trench be placed to 40 blow/foot residual soils under the left abutment and channel section and to the shallow (approx. 5') top of weathered rock under the right abutment. The detail of the cutoff trench shown as plate III, Appendix I, shows these approximate depths, however, the final depth of the trench was to be determined by the field engineer. It is apparent, though, that the trench was not placed below the fault zones.

Construction reports were not available to check the actual figures or determine the actual foundation materials and their conditions at the bottom of the cutoff trench and below the seepage drain. It is assumed that the trench was placed into impermeable residual soils or weathered bedrock as recommended and that the seepage drain was founded on impermeable weathered bedrock as shown in the detail on plate VI, Appendix I.

6.2 <u>Embankment</u>: Referring to Plate No. IV, Appendix I, the crest of the dam is 14 ft. wide at El. 397.2. The upstream slope of the shell is 1 vertical to 2-1/2 horizontal from the crest of dam to El. 378.0 where it flattens to 1 vertical to 10 horizontal, forming a berm for a vertical distance of 1 foot. The flat berm protects the upstream shoreline from erosion during the normal pool operation. From El. 377, the slope changes to 1 vertical on 3 horizontal to natural ground. The downstream slope of the shell is 1 vertical to 2-1/2 horizontal from crest to toe of dam. The upstream slope of the inner core is 1 vertical to 2-1/2 horizontal and it follows essentially the outline of the upstream shell. The downstream slope of the inner core is 1 vertical to 2 horizontal. The inner core is constructed with mostly ML and some CL materials compacted in 9-inch lift at or above the optimum moisture content. The outer shell is constructed with SM and non-plastic ML material compacted in 9-inch

lift. The seepage drain is located at the outer shell material under the downstream portion of the dam. Although no specific dimension is given on Plate VI, Appendix I, the location of the drain appears to satisfy the design condition of c/b = 0.6.

6.3 Evaluation:

6.3.1 Foundation:

Most dam foundations are evaluated on the basis of potential settlement, sliding and seepage. Excessive settlement of the dam is not a problem because the foundation is composed of fairly dense soils overlying weathered bedrock and settlement was not noted along the dam alignment during the visual inspection. Sliding within the foundation bedrock is not usually a problem under small, earth dams. In addition, there are no adversely oriented weak planes within the foundation bedrock that would act as a potential sliding plane. The potential for seepage does exist within the foundation since the dam is founded partly on soil types that are fairly permeable and overlie faulted bedrock. The cutoff trench and seepage drain were placed below the permeable soils but not below the fault zones. Since the hydraulic head behind the dam is only 8 feet during normal pool and 20 feet at the emergency spillway, it was probably determined that unsafe seepage would not develope through the fault zones at those low heads, thereby eliminating the need for a deeper trench. This is a valid determination especially since no seepage has ever occured downstream of the dam. It is recommended, however, that close monitoring of the toe drain and downstream area be done during high (flood) water conditions to assure against unsafe seepage.

6.3.2 Embankment:

The embankment structure was checked with the modified Swedish circle and the sliding block methods. According to the available information given in Appendix VI, only one trial analysis was made for the upstream slope by each method. Similarily, only one trial analysis was made for the downstream slope. The factor of safety determined are therefore not the minimum factor of safety for the slopes. The factor of safety presented below refers only to the trial analysis. This is not the customary procedure used in stability analysis. As the dam is built on stratified foundation, the sliding block method showed the lower factor of safety. Referring to Appendix V, the factor of safety for the upstream slope is 2.25 for the full drawdown condition from pool level at emergency spillway crest elevation 386.9 (actual crest elevation is 388.5 ft.). The factor of safety for the downstream slope is 2.27 for the full steady seepage condition (pool level at EMS) with drain located at c/b = 0.6. The embankment structure considered for the Swedish circle

method is different from the sliding block method given in Appendix VI. The embankment structure used in the sliding block method is more representative of the actual embankment which was analysed as a structure with a 14 ft. wide crest and 32.9 ft. high fill section over 4 ft. of foundation. No calculations for the stability analyses were available. See Appendix V for additional information on stability analyses.

The embankment slopes meet the requirement recommended by the U.S. Bureau of Reclamation for small zoned earthfill dams on stable foundation according to Reference 2, Appendix VII. Since no undue settlement, crack or seepage was noted at the time of inspection, it appears that the embankment is adequate for normal pool level at El. 376.5 ft.

SECTION 7 ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Reference 1, Appendix VII, recommends a Spillway Design Flood equivalent to the PMF. Since the PMF does not top the crest of the dam, the emergency spillway is considered adequate.

Based on the visual inspection and review of existing records, there is no apparent problem that would require immediate action for the normal pool conditions. The actual embankment structure appears to be similar to the "as-built" drawings. Without the construction records, and without performing the stability analysis according to the recommendation given in Reference 1, Appendix VII, the stability of the embankment under designed loading conditions cannot be assessed although the embankment slope and crest width meet the requirements recommended by the U.S. Bureau of Reclamation for small zoned earthfill dams on stable foundation given in Reference 2, Appendix VII.

7.2 Remedial Measures: There is no immediate need for remedial measures. However, the following actions are suggested and should be initiated within 12 months. These measures are suggested for monitoring and maintenance purposes only.

7.2.1 The grasses on the faces of embankment should be maintained in such a condition that will facilitate the annual inspection.

7.2.2 Remove woody vegetation in downstream discharge channel riprap to eliminate deep rooted growth.

7.2.3 Backfill animal burrows located in the embankments to eliminate erosion.

7.2.4 Provide slope protection on the upstream slope against erosion at the pool elevation.

7.2.5 The crest of the dam should be closed to vehicular traffic and the bare spots should be reseeded. In the event that the traffic cannot be successfully controlled, the crest must be paved to protect against erosion.

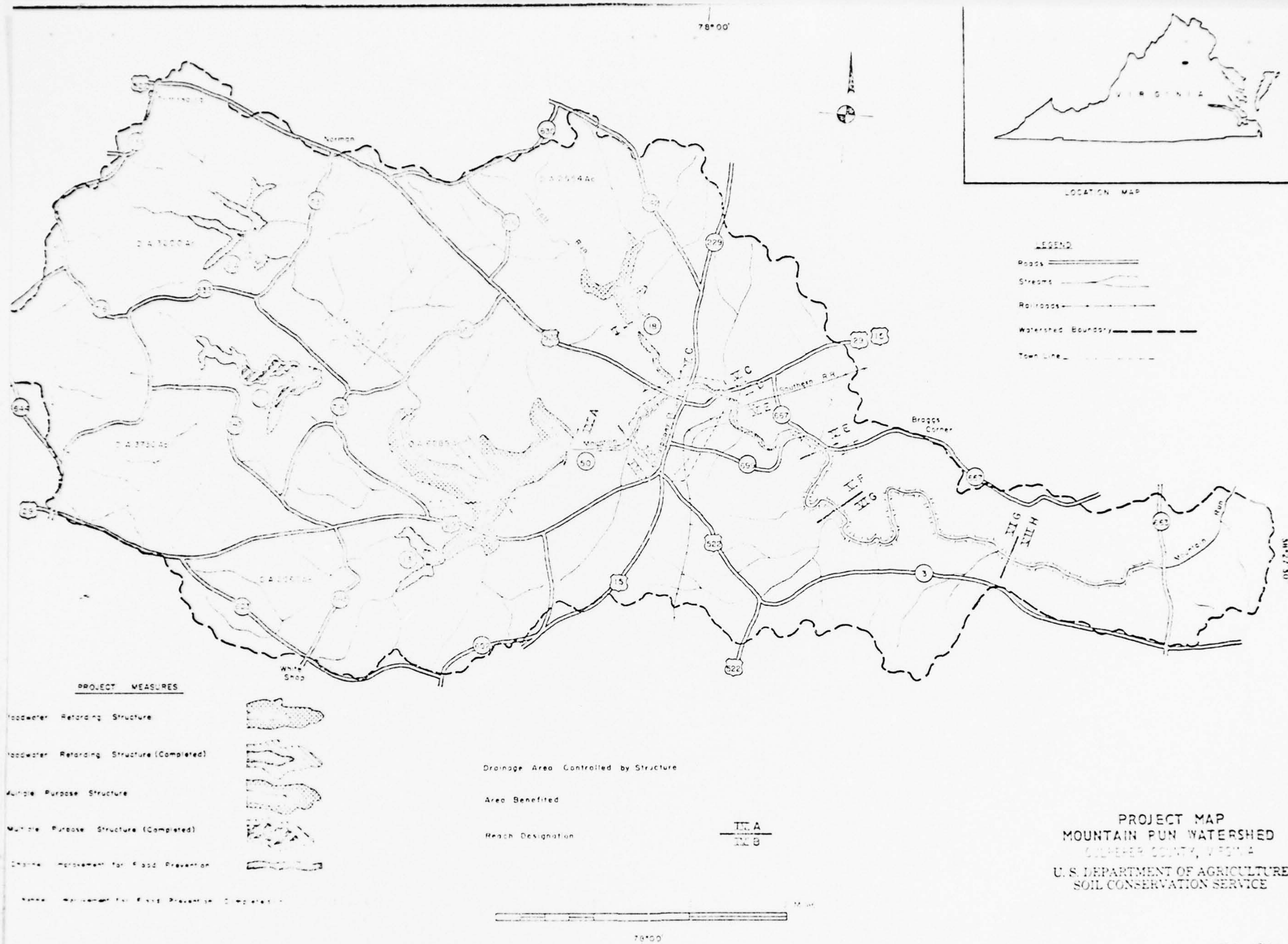
7.2.6 The current annual inspection program should include observations and measurement, if feasible, of the flow rate of the seepage drain. In the event that the drainage water is murky, an analysis of the suspended solids should be made to determine the source of these solids.

7.2.7 Record the pool elevation and flow rate of the seepage drain whenever the pool level rises 6 ft. or more above the normal pool elevation. Staff gage or other equivalent method should be placed to indicate the pool level.

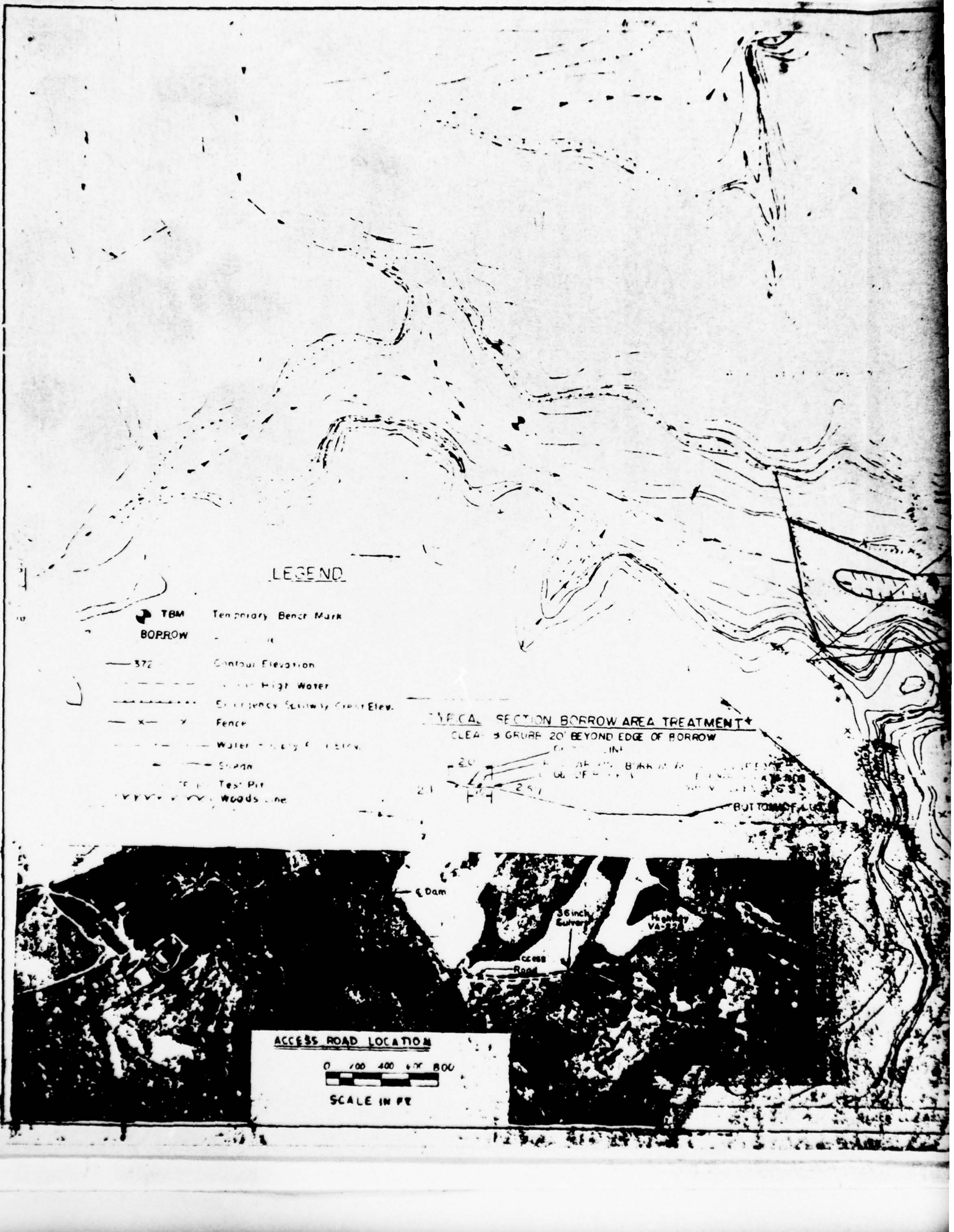
7.2.8 Suggest to perform stability analysis with the "as-built" conditions and appropriate material properties using the guidelines recommended by Reference 1, Appendix VII and the sliding block or wedge method to check the stability of slopes.

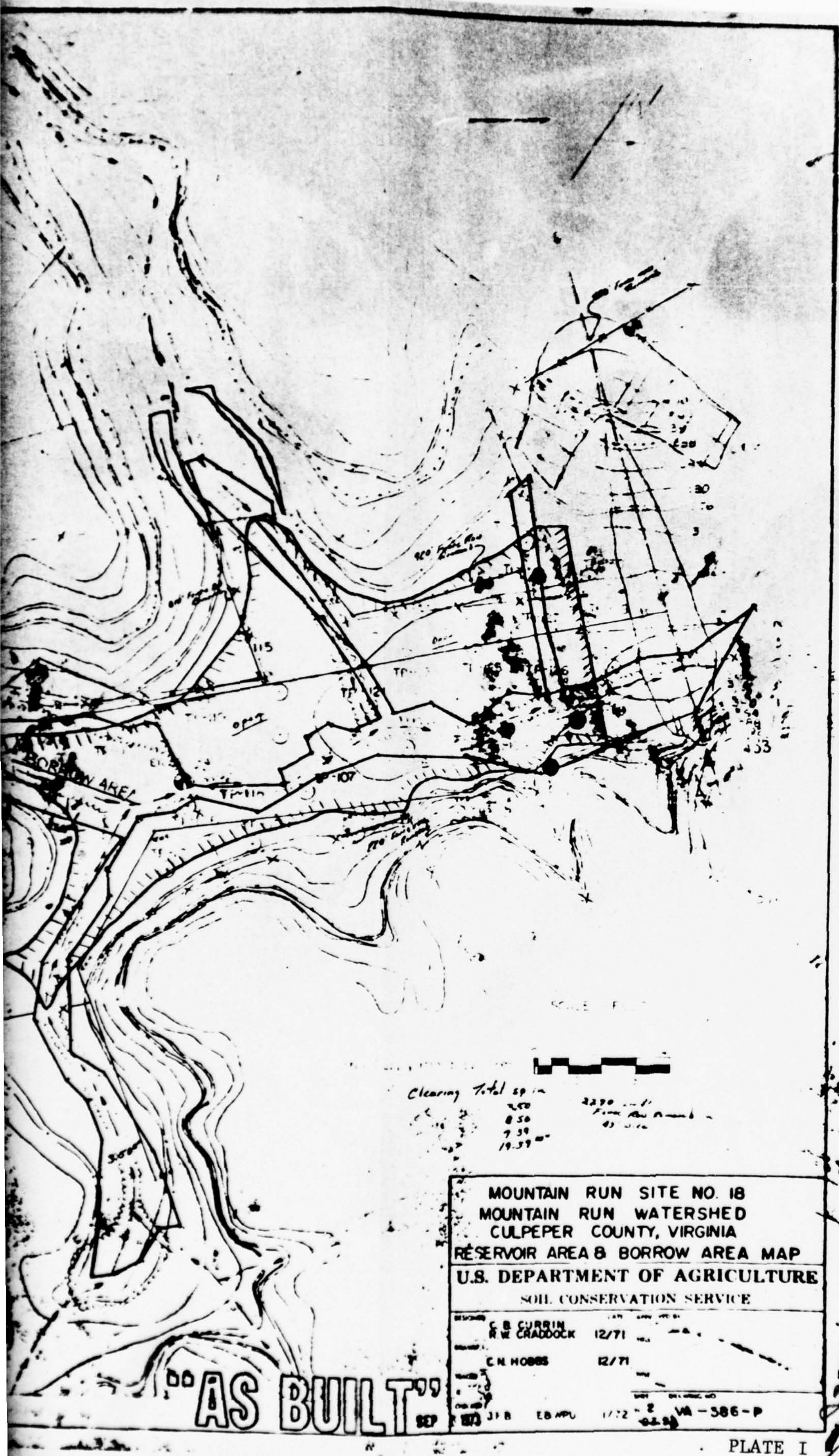
APPENDIX I

MAPS AND DRAWINGS



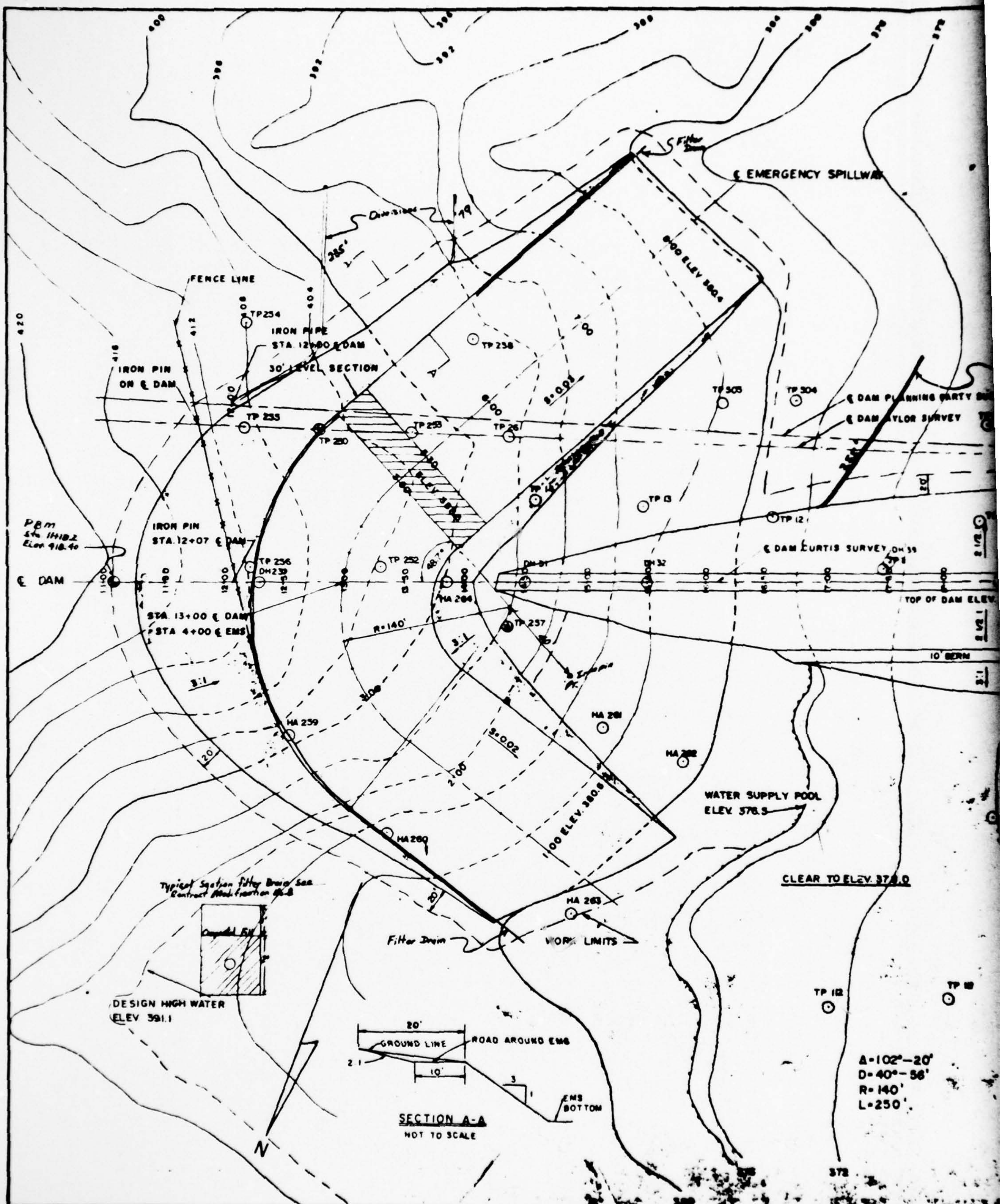
78°00'
LOCATION MAP
VIRGINIA
LEGEND
Roads
Streams
Railroads
Watershed Boundary
Town Line
Norman
Braggs Corner
Southern R.R.
White Shop
Mountain Run
PROJECT MEASURES
Floodwater Retarding Structure
Floodwater Retarding Structure (Completed)
Multiple Purpose Structure
Multiple Purpose Structure (Completed)
Channel Improvement for Flood Prevention
Drainage Area Controlled by Structure
Area Benefited
Reach Designation
2 Miles
PROJECT MAP
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE


LEGEND
TBM
Temporary Bench Mark
BORROW
372
Contour Elevation
High Water
Fence
Stream
Test Pit
Woods Line
SECTION BORROW AREA TREATMENT
BEYOND EDGE OF BORROW
Dam
Culvert
Road
ACCESS ROAD LOCATION
400
800
SCALE IN FT



Clearing Total sq in
2.50
8.50
7.39
19.39
MOUNTAIN RUN SITE NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
RESERVOIR AREA & BORROW AREA MAP
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
C. B. CURRIN
R. W. CRADDOCK 12/71
C. N. HOBBS 12/71
VA-386-P
"AS BUILT"
SEP 1973

PLATE I



€ EMERGENCY SPILLWAY
FENCE LINE
TP 234
IRON PIPE
STA. 12+00 € DAM
30' LEVEL SECTION
IRON PIN
ON € DAM
TP 235
TP 250
TP 253
TP 236
TP 305
TP 304
€ DAM PLANNING PARTY SURVEY
€ DAM TAYLOR SURVEY
TP 13
TP 12
PBM
Sta. 11+18.2
Elev. 418.40
IRON PIN
STA. 12+07 € DAM
TP 256
DH 239
TP 252
€ DAM CURTIS SURVEY
€ DAM
HA 264
STA. 13+00 € DAM
STA 4+00 € EMS
R=140'
TP 257
TOP OF DAM ELEV.
10' BERM
3:1
HA 239
HA 261
HA 262
S=0.002
1+00 ELEV. 380.6
0+00 ELEV. 380.4
WATER SUPPLY POOL
ELEV. 376.5
HA 260
CLEAR TO ELEV. 378.0
Typical Section Filter Drain See Contract Modification
Compacted Fill
HA 263
Filter Drain
WORK LIMITS
DESIGN HIGH WATER
ELEV. 391.1
TP 112
20'
GROUND LINE
ROAD AROUND EMS
10'
EMS
BOTTOM
SECTION A-A
NOT TO SCALE
N
Δ=102°-20'
D=40°-56'
R=140'
L=250'.

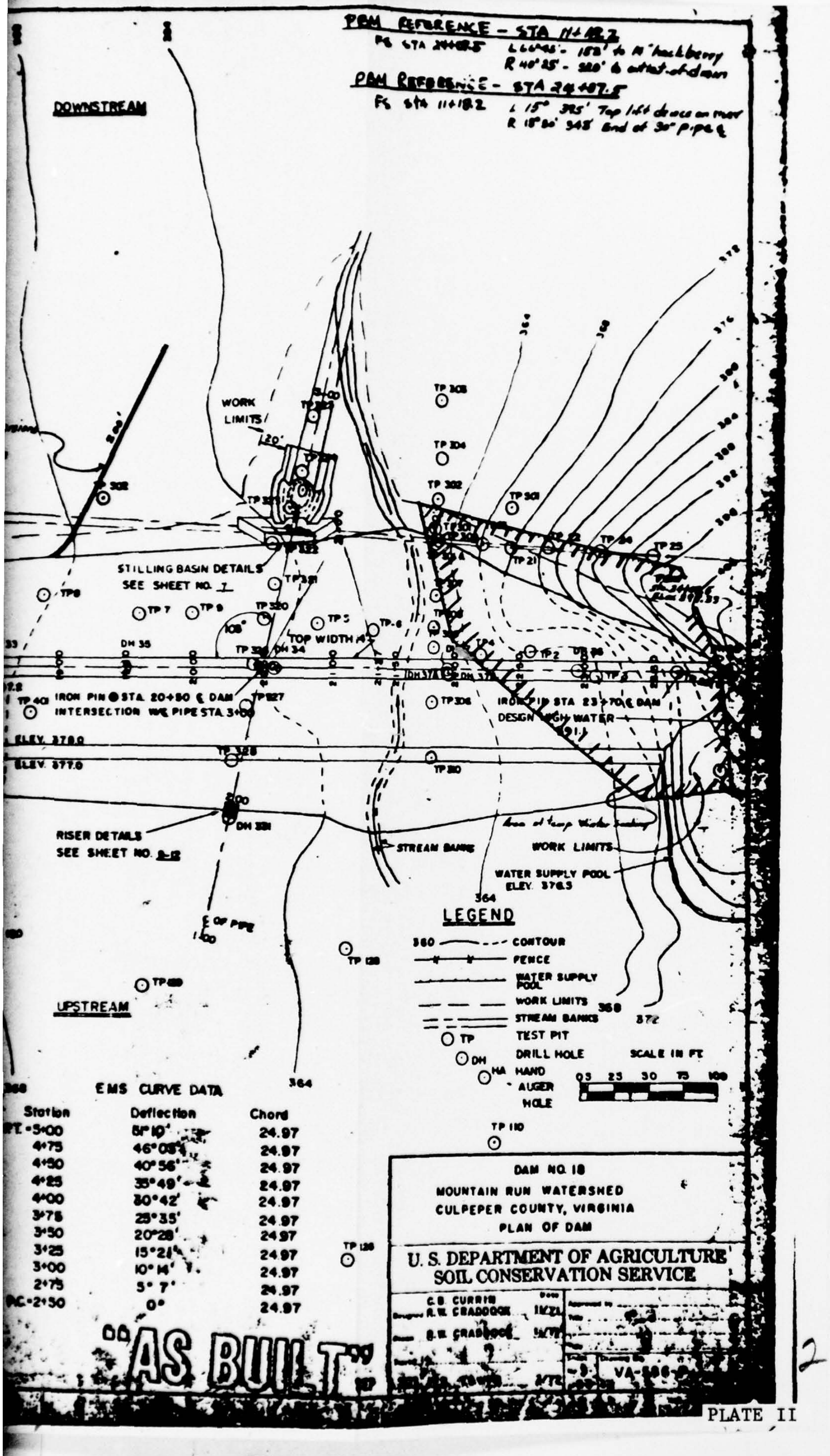
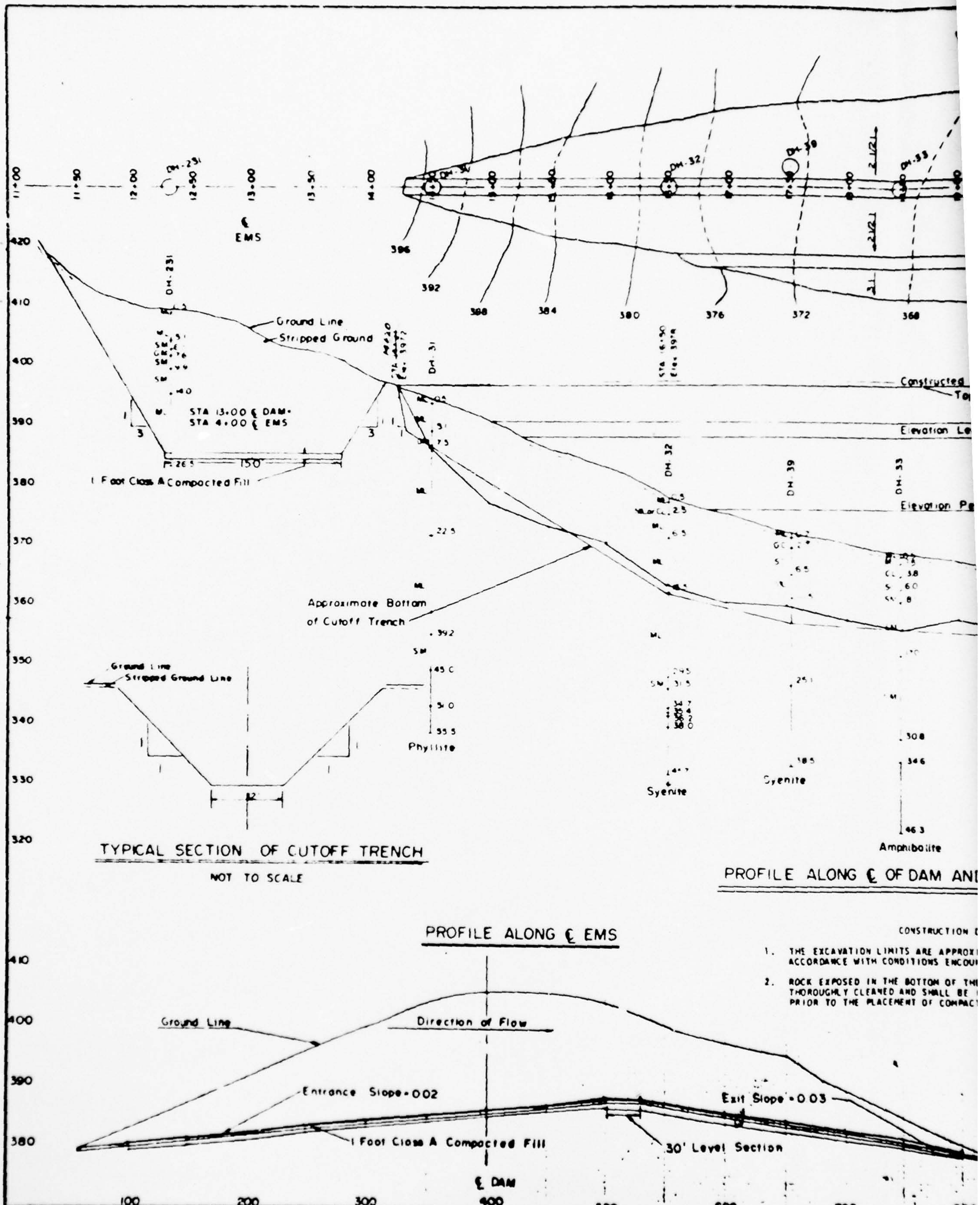
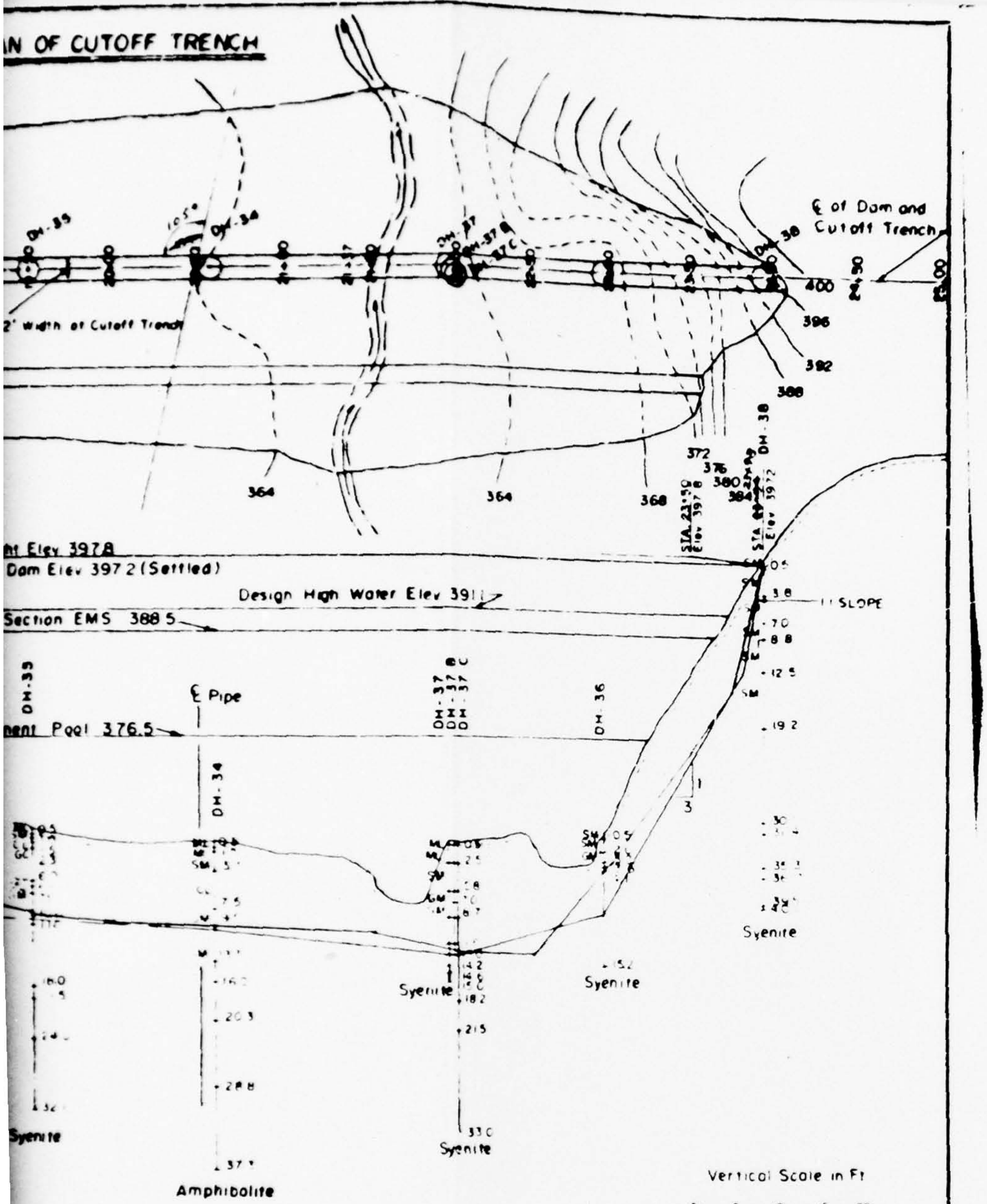

DAM REFERENCE - STA 11+18.2
DAM REFERENCE - STA 24+07.5
DOWNSTREAM
WORK LIMITS
STILLING BASIN DETAILS
SEE SHEET NO. 7
TOP WIDTH 14'
IRON PIN @ STA. 20+80 ℄ DAM
INTERSECTION W/℄ PIPE STA. 3+00
IRON PIN STA 23+70 ℄ DAM
DESIGN HIGH WATER
ELEV. 378.0
ELEV. 377.0
RISER DETAILS
SEE SHEET NO. 8-12
STREAM BANKS
WORK LIMITS
WATER SUPPLY POOL
ELEV. 376.5
℄ OF PIPE
UPSTREAM
LEGEND
CONTOUR
FENCE
WATER SUPPLY POOL
WORK LIMITS
STREAM BANKS
TEST PIT
DRILL HOLE
HAND AUGER HOLE
SCALE IN FT
EMS CURVE DATA
Station
Deflection
Chord
DAM NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
PLAN OF DAM
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
"AS BUILT"

PLATE II



TYPICAL SECTION OF CUTOFF TRENCH
NOT TO SCALE
PROFILE ALONG ℄ OF DAM AND
PROFILE ALONG ℄ EMS
℄ EMS
Ground Line
Stripped Ground
STA 13+00 ℄ DAM
STA 4+00 ℄ EMS
1 Foot Class A Compacted Fill
Approximate Bottom of Cutoff Trench
Stripped Ground Line
Phyllite
Syenite
Amphibolite
Constructed
Elevation Le
Elevation Pe
Direction of Flow
Entrance Slope - 0.02
Exit Slope - 0.03
30' Level Section
℄ DAM
CONSTRUCTION
1. THE EXCAVATION LIMITS ARE APPROXI ACCORDANCE WITH CONDITIONS ENCOU
2. ROCK EXPOSED IN THE BOTTOM OF THE THOROUGHLY CLEANED AND SHALL BE PRIOR TO THE PLACEMENT OF COMPACT

[...]AN OF CUTOFF TRENCH



[...]CUTOFF TRENCH

[...]LS:

[...] AND WILL BE ADJUSTED IN [...]D.

[...]FF TRENCH SHALL BE [...]TED BY THE ENGINEER [...]LL MATERIAL.

"AS BUILT"

SEP 6 1973

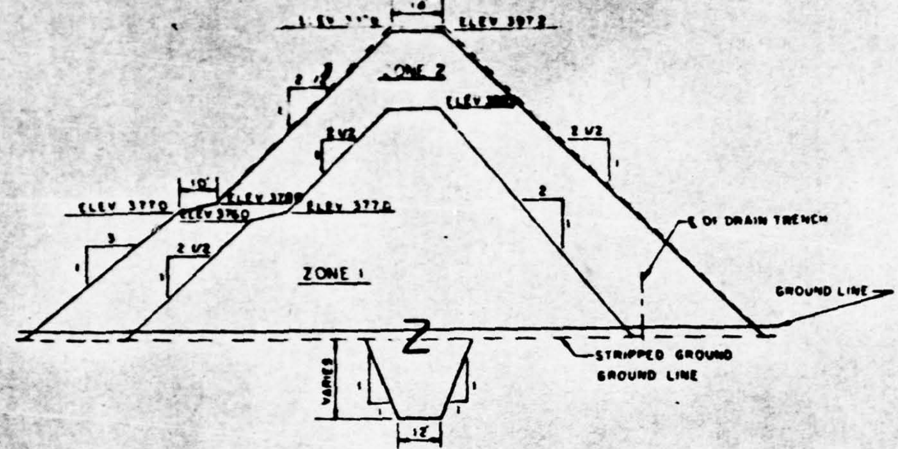
MOUNTAIN RUN SITE NO 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
DETAILS OF CUTOFF TRENCH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

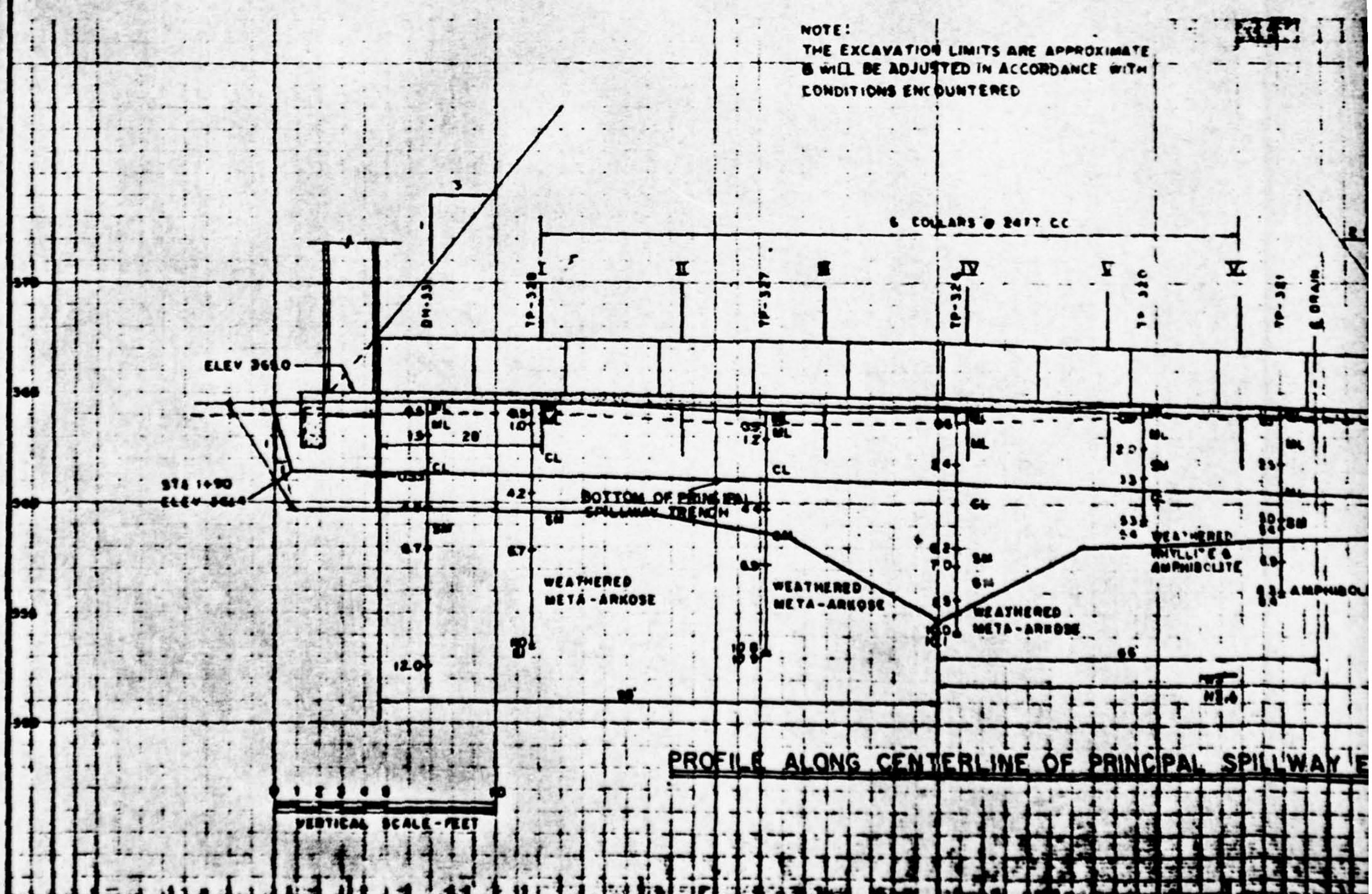
Designed	C B CURRIN R W CRADDOCK	2/71
Drawn	C N HOBBS	12/71
Checked		
Approved	B EBWPU	1/72

Sheet 5 of 38 — Drawing No. VA-586-P

PLATE III



TYPICAL SECTION OF COMPACTED FILL



PROFILE ALONG CENTERLINE OF PRINCIPAL SPILLWAY E

PLACEMENT OF EARTH FILL MATERIALS

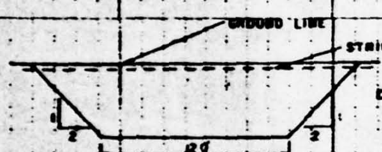
FILL MATERIALS				RECOMMENDED COMPACTION REQUIREMENTS						REFERENCE COMPACTION TEST					
LOCATION	AVERAGE DEPTH (FT.) FROM	TO	DESCRIPTION	CLASS	DEGREE OF COMPACTION (%)	MOISTURE LIMITS (%) ± OPTIMUM FROM	TO	CONTROL TEST ASTM DESIGNATION	METHOD	SAMPLE NO. FIELD	LAB.	MAXIMUM DENSITY (pcf)	OPTIMUM MOISTURE (%)	[illegible]	MAXIMUM LIFT THICKNESS
EMERGENCY SPILLWAY	1	6.[illegible]	[illegible] SILT, SANDY [illegible] YELLOW, RED, HARD, MOIST	[illegible]	95	[illegible]	[illegible]	D-[illegible]	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BORROW	1	8.[illegible]	[illegible] SILT, CLAYEY [illegible] YELLOW MOTTLES [illegible] HARD MOIST	[illegible]	[illegible]	[illegible]	[illegible]	D-[illegible]	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BORROW	1	2.[illegible]	[illegible] SILT, CLAYEY [illegible] MOIST	A	[illegible]	[illegible]	[illegible]	D-[illegible]	A	110-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BORROW	2.4	[illegible]	[illegible] SILT, CLAYEY [illegible] MOTTLES [illegible] MOIST	[illegible]	[illegible]	[illegible]	[illegible]	D-[illegible]	[illegible]	110-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BORROW	2.[illegible]	[illegible]	[illegible] SILTY [illegible] HARD [illegible] MOTTLED GRAY AND [illegible] BROWN HARD [illegible] MOIST	A	[illegible]	[illegible]	[illegible]	D-[illegible]	A	111-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EMERGENCY SPILLWAY	5.6	11.0	[illegible] SAND, SILTY YELLOW [illegible] HARD [illegible]	A	[illegible]	[illegible]	[illegible]	D-[illegible]	A	257-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BORROW	2.7	[illegible]	[illegible] SAND, SILTY [illegible] HARD-MOIST	A	[illegible]	[illegible]	[illegible]	[illegible]	A	109-1	[illegible]	[illegible]	13.[illegible]	[illegible]	[illegible]

[illegible] maximum [illegible] size = 3

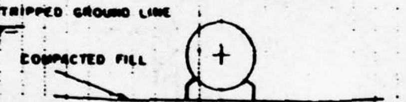
[illegible] of placement [illegible] compaction [illegible] see sheet 16

[illegible] principal spillway [illegible]

See sheet 17, 18 and 19 [illegible]

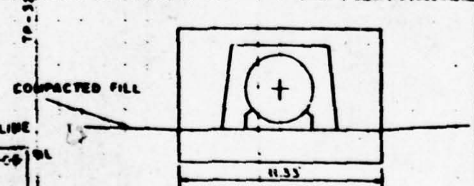


PRINCIPAL SPILLWAY TRENCH EXCAVATION



PRINCIPAL SPILLWAY BACKFILL

NOT TO SCALE

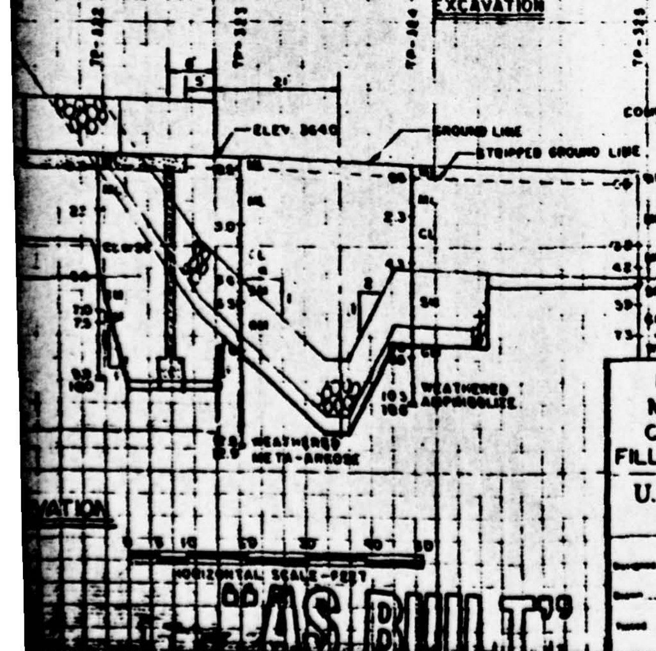


COLLAR I THROUGH III

PRINCIPAL SPILLWAY EXCAVATION

ANTI-SEEP COLLAR

NOT TO SCALE



[illegible]VATION

0 5 10 20 30 40 50

HORIZONTAL SCALE-FEET

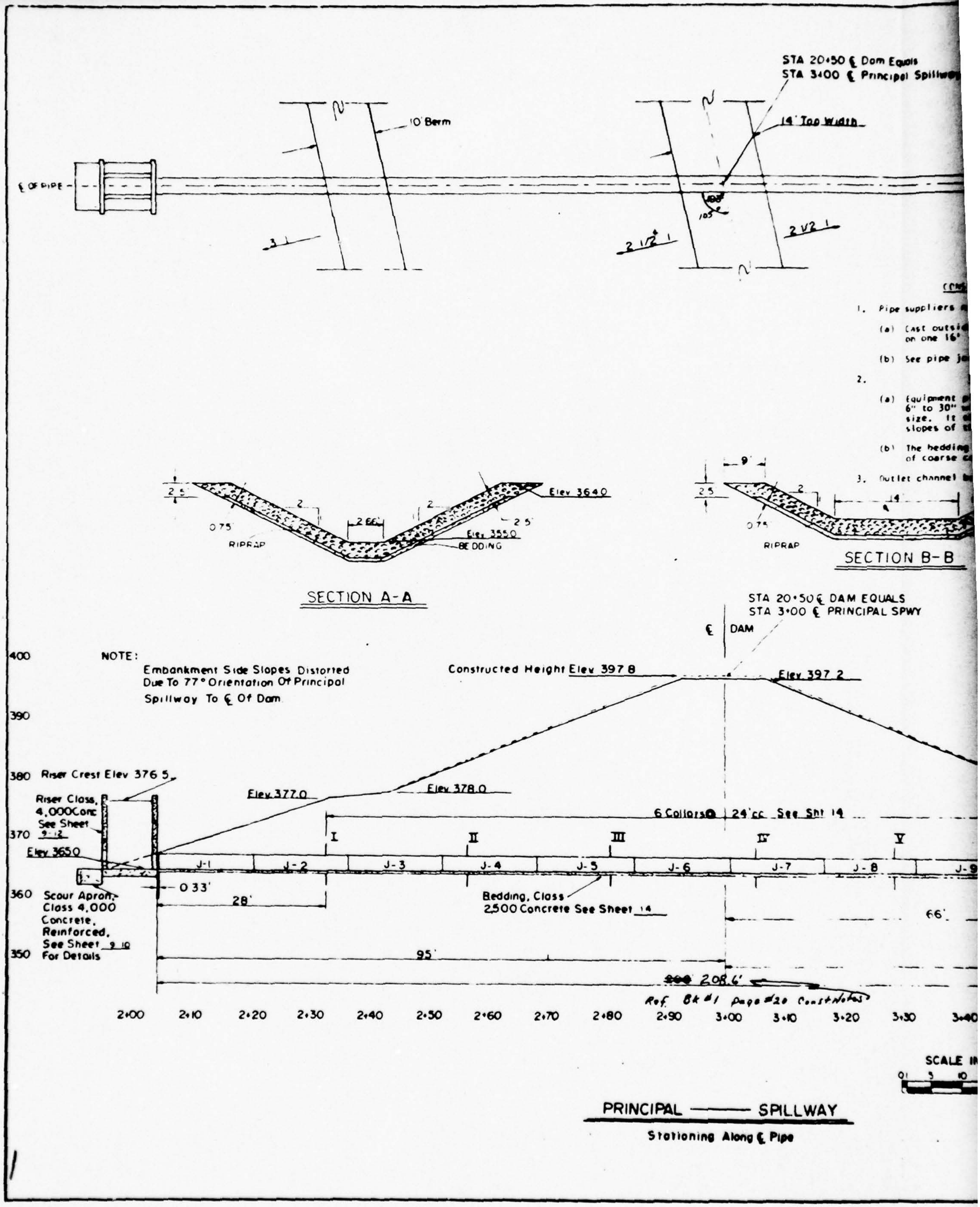
"AS BUILT"

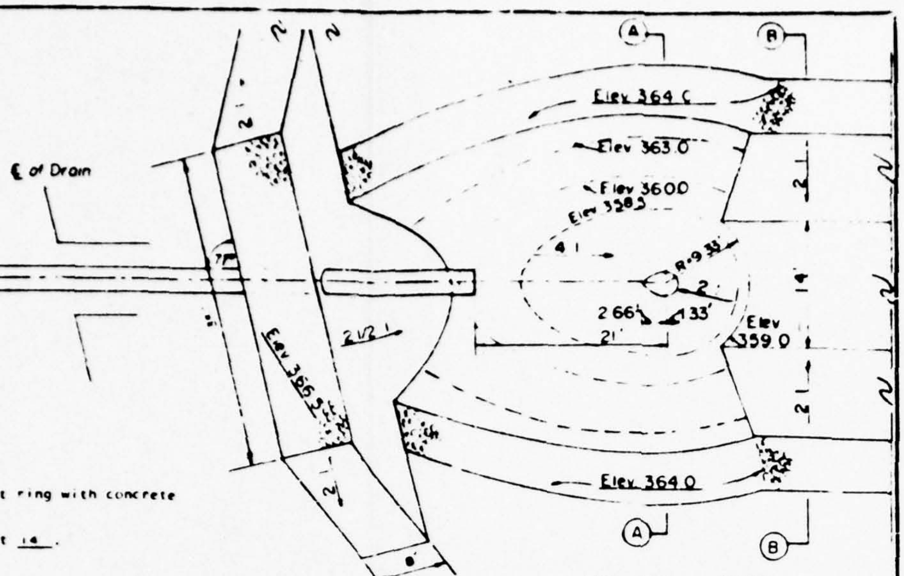
MOUNTAIN RUN SITE NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
FILL PLACEMENT & SPILLWAY EXCAVATION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	C.B. CURRIN R.W. CRADDOCK	[illegible]
Drawn	R.W. CRADDOCK	[illegible]
Traced		
Checked	JFB EBWPV	[illegible]

Drawing No. VA-386-P


STA 20+50 ℄ Dam Equals
STA 3+00 ℄ Principal Spillway
10' Berm
14' Top Width
℄ OF PIPE
3:1
2 1/2:1
2 1/2:1
1. Pipe suppliers
(a) Cast outside
on one 16'
(b) See pipe
2.
(a) Equipment
6" to 30"
size. It
slopes of
(b) The bedding
of coarse
3. Outlet channel
2.5'
0.75'
2
2.66'
2
2.5'
Elev 364.0
Elev 355.0
RIPRAP
BEDDING
SECTION A-A
9'
2.5'
2
14'
0.75'
RIPRAP
SECTION B-B
STA 20+50 ℄ DAM EQUALS
STA 3+00 ℄ PRINCIPAL SPWY
℄ DAM
NOTE:
Embankment Side Slopes Distorted Due To 77° Orientation Of Principal Spillway To ℄ Of Dam
Constructed Height Elev 397.8
Elev 397.2
400
390
380
370
360
350
Riser Crest Elev 376.5
Riser Class 4,000 Conc See Sheet 9-12
Elev 377.0
Elev 378.0
6 Collars @ 24' cc See Sht 14
I
II
III
IV
V
Elev 365.0
J-1
J-2
J-3
J-4
J-5
J-6
J-7
J-8
J-9
0.33'
28'
Scour Apron, Class 4,000 Concrete, Reinforced, See Sheet 9-10 For Details
Bedding, Class 2,500 Concrete See Sheet 14
66'
95'
~~200~~ 208.6'
Ref. Bk #1 Page #20 Const Notes
2+00
2+10
2+20
2+30
2+40
2+50
2+60
2+70
2+80
2+90
3+00
3+10
3+20
3+30
3+40
SCALE IN
0
5
10
PRINCIPAL —— SPILLWAY
Stationing Along ℄ Pipe



...NSTRUCTION DETAILS

...s notes:

...side of spigot joint ring with concrete ...6' - 0" section.

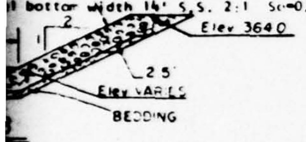
... joint details sheet 14.

RIPRAP NOTE

...t placed riprap shall be graded from ..." with at least 50% greater than 12" in ...t shall be laid on 9" of bedding on the ...f the basin.

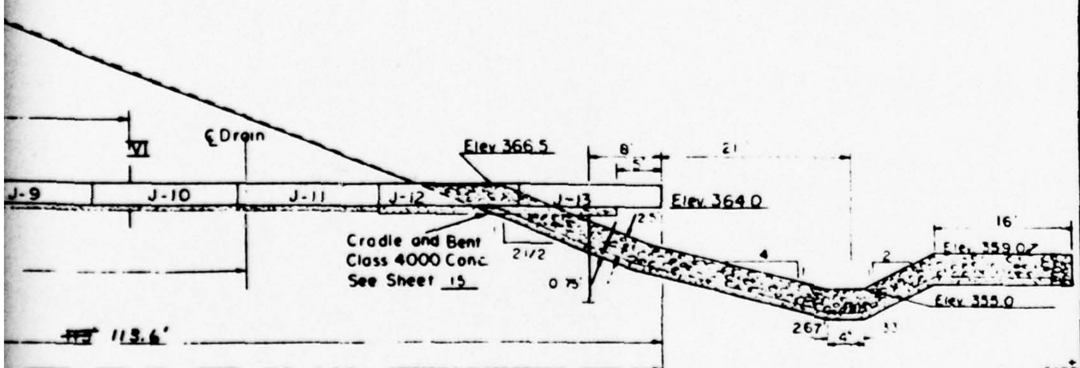
...ding shall meet the gradation requirements ...e concrete aggregate.

...l bottom width 14' S.S. 2:1 So=0.01 1/1



JOINT	DIST. FROM RISER TOE	INVERT ELEV.	SLOPE
J-1	0.33	365.0	
J-2	16.33	364.97	S=.000166
J-3	32.33	364.95	
J-4	48.33	364.92	
J-5	64.33	364.90	
J-6	80.33	364.67	
J-7	96.33	364.64	
J-8	112.33	364.72	
J-9	128.33	364.60	S_2=.00075
J-10	144.33	364.48	
J-11	160.33	364.36	
J-12	176.33	364.24	
J-13	192.33	364.12	
Outlet	208.33	364.0	

COLLAR	DIST. FROM RISER TOE	INVERT ELEV.	SLOPE
I	28.33	364.95	S=.000166
II	52.33	364.91	
III	76.33	364.87	
IV	100.33	354.81	S_2=.00075
V	124.33	364.63	
VI	148.33	364.45	



"AS BUILT"

SEP 6 1973

MOUNTAIN RUN SITE NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
PRINCIPAL SPILLWAY

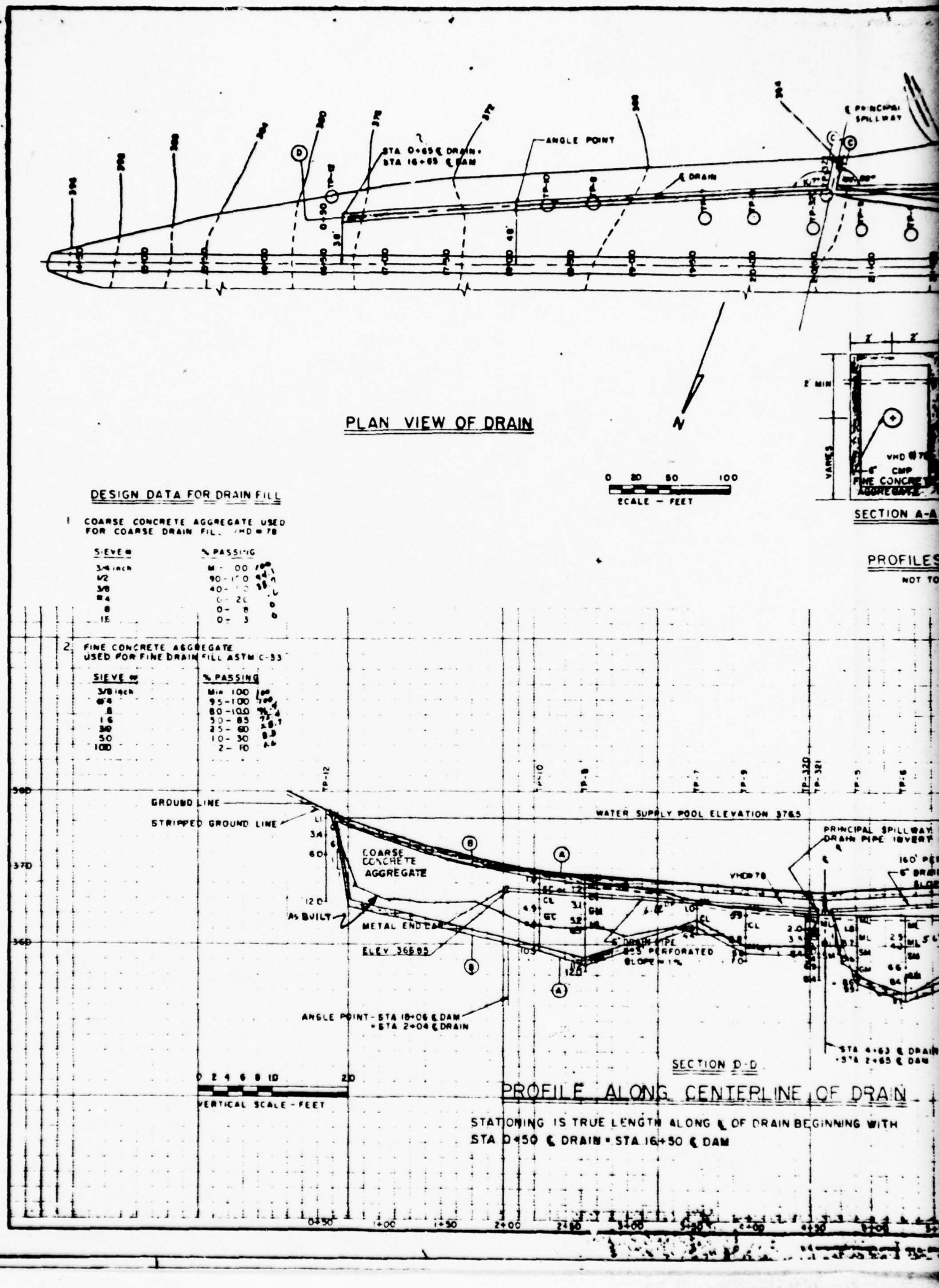
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	C. B. CURRIN R. W. CRADDOCK	12/71
Drawn	C. N. HOBBS	12/71
Traced		
Checked	JFB EBWPU	1/72

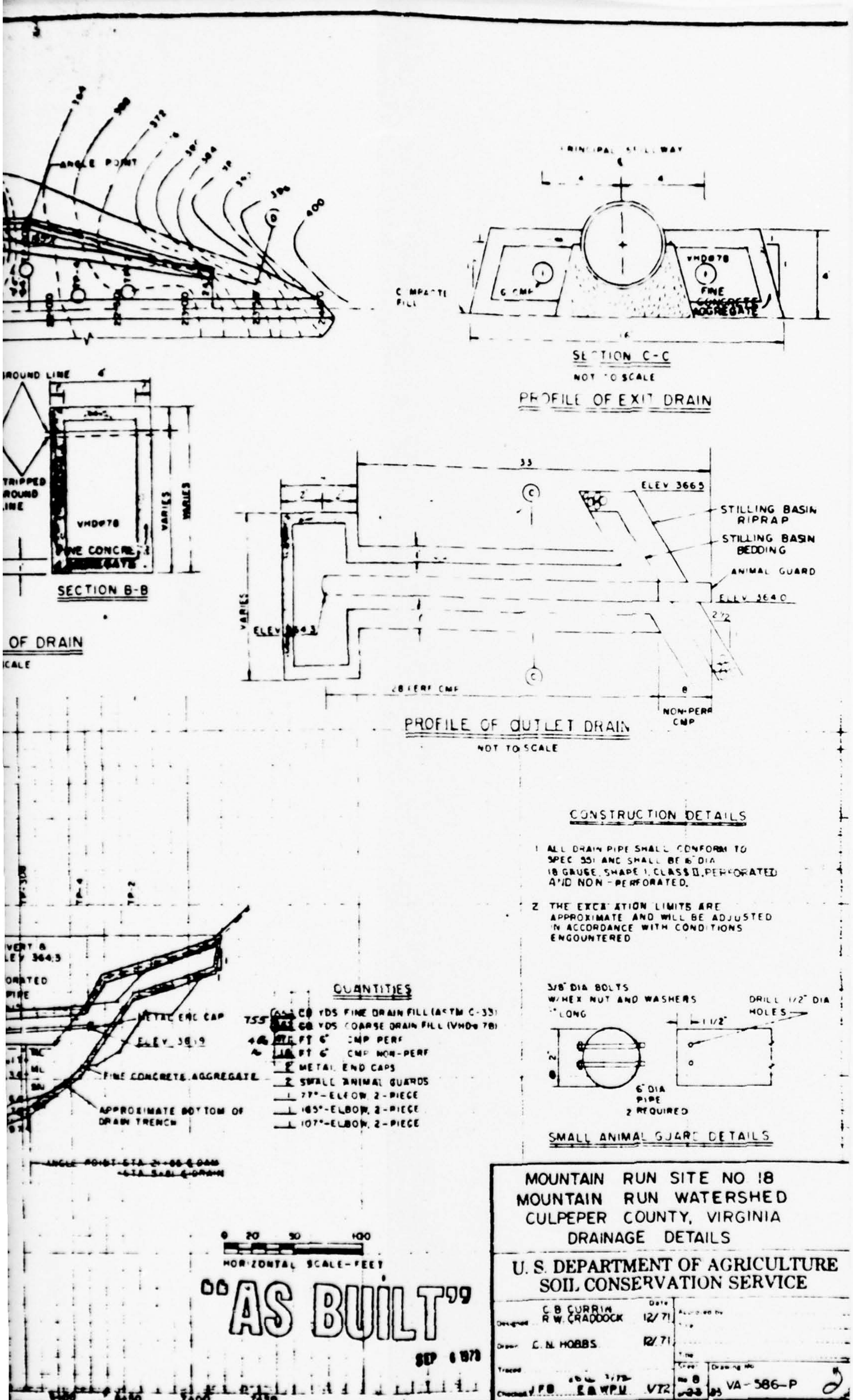
Sheet 7 of 38 — Drawing No. VA-586-P

2

PLATE V

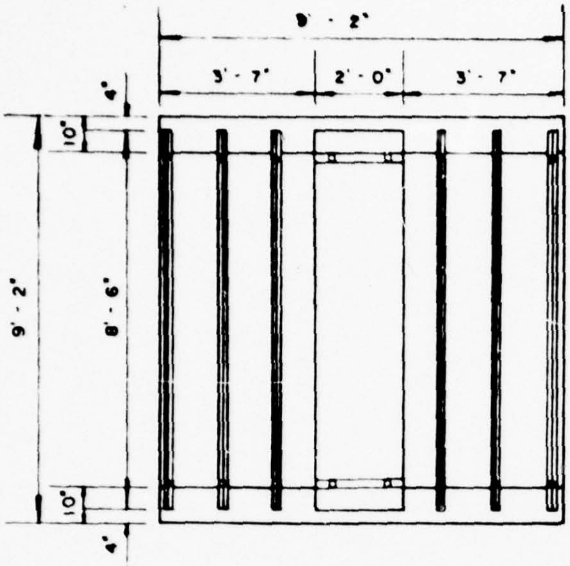


PLAN VIEW OF DRAIN
STA 0+65 ℄ DRAIN = STA 16+65 ℄ DAM
ANGLE POINT
℄ DRAIN
℄ PRINCIPAL SPILLWAY
N
0 20 50 100
SCALE - FEET
SECTION A-A
2' MIN
VARIES
VHD #78
6" CMP
FINE CONCRETE AGGREGATE
PROFILES
DESIGN DATA FOR DRAIN FILL
1 COARSE CONCRETE AGGREGATE USED FOR COARSE DRAIN FILL VHD = 78
SIEVE # | % PASSING
3/4 inch | Min 100
1/2 | 90-100
3/8 | 40-70
#4 | 0-20
8 | 0-8
16 | 0-3
2. FINE CONCRETE AGGREGATE USED FOR FINE DRAIN FILL ASTM C-33
SIEVE # | % PASSING
3/8 inch | Min 100
#4 | 95-100
8 | 80-100
16 | 50-85
30 | 25-60
50 | 10-30
100 | 2-10
GROUND LINE
STRIPPED GROUND LINE
WATER SUPPLY POOL ELEVATION 3765
COARSE CONCRETE AGGREGATE
AS BUILT
METAL END CAP
ELEV 3658.5
6" DRAIN PIPE 825 PERFORATED SLOPE = 1%
PRINCIPAL SPILLWAY
DRAIN PIPE INVERT
160' PERF
6" DRAIN
ANGLE POINT - STA 18+06 ℄ DAM = STA 2+04 ℄ DRAIN
STA 4+63 ℄ DRAIN = STA 2+65 ℄ DAM
SECTION D-D
PROFILE ALONG CENTERLINE OF DRAIN
STATIONING IS TRUE LENGTH ALONG ℄ OF DRAIN BEGINNING WITH STA 0+50 ℄ DRAIN = STA 16+50 ℄ DAM
0 2 4 6 8 10 20
VERTICAL SCALE - FEET
3800
3700
3600
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00

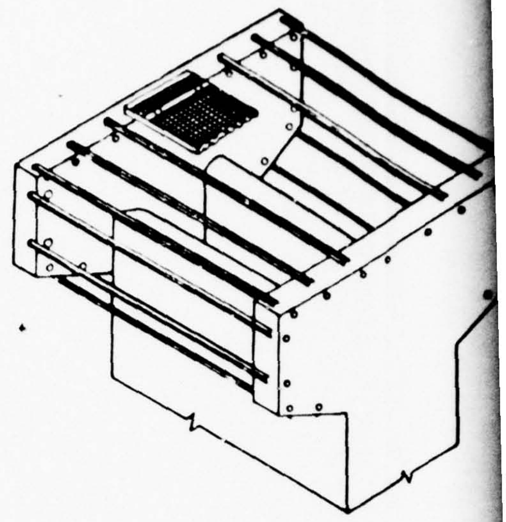


PRINCIPAL SPILLWAY
VHD#78
FINE CONCRETE AGGREGATE
COMPACTED FILL
SECTION C-C
NOT TO SCALE
PROFILE OF EXIT DRAIN
GROUND LINE
STRIPPED GROUND LINE
VARIES
FINE CONCRETE AGGREGATE
SECTION B-B
OF DRAIN
ELEV 366.5
STILLING BASIN RIPRAP
STILLING BASIN BEDDING
ANIMAL GUARD
ELEV 364.0
ELEV 364.3
28 PERF CMP
NON-PERF CMP
PROFILE OF OUTLET DRAIN
NOT TO SCALE
CONSTRUCTION DETAILS
1. ALL DRAIN PIPE SHALL CONFORM TO SPEC 551 AND SHALL BE 6" DIA 18 GAUGE, SHAPE 1, CLASS II, PERFORATED AND NON-PERFORATED.
2. THE EXCAVATION LIMITS ARE APPROXIMATE AND WILL BE ADJUSTED IN ACCORDANCE WITH CONDITIONS ENCOUNTERED.
QUANTITIES
CU YDS FINE DRAIN FILL (ASTM C-33)
CU YDS COARSE DRAIN FILL (VHD# 78)
FT 6" CMP PERF
FT 6" CMP NON-PERF
METAL END CAPS
SMALL ANIMAL GUARDS
77°-ELBOW, 2-PIECE
165°-ELBOW, 2-PIECE
107°-ELBOW, 2-PIECE
METAL END CAP
ELEV 361.9
FINE CONCRETE AGGREGATE
APPROXIMATE BOTTOM OF DRAIN TRENCH
3/8" DIA BOLTS W/HEX NUT AND WASHERS
DRILL 1/2" DIA HOLES
6" DIA PIPE
2 REQUIRED
SMALL ANIMAL GUARD DETAILS
HORIZONTAL SCALE-FEET
"AS BUILT"
SEP 6 1973
MOUNTAIN RUN SITE NO 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
DRAINAGE DETAILS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
C.B. CURRIN
R.W. CRADDOCK
12/71
C. N. HOBBS
12/71
VA-586-P

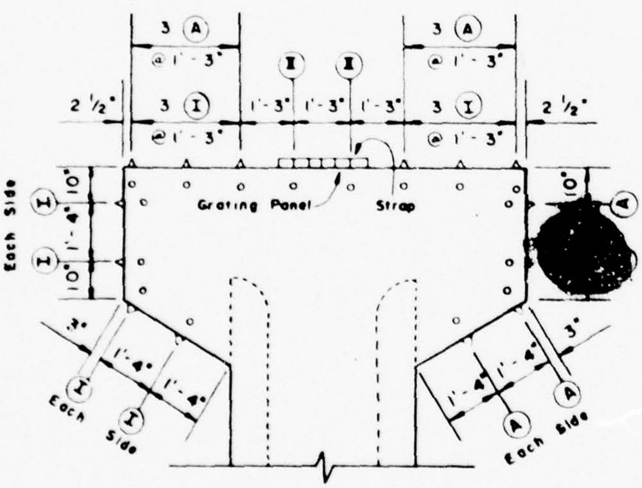
PLATE VI



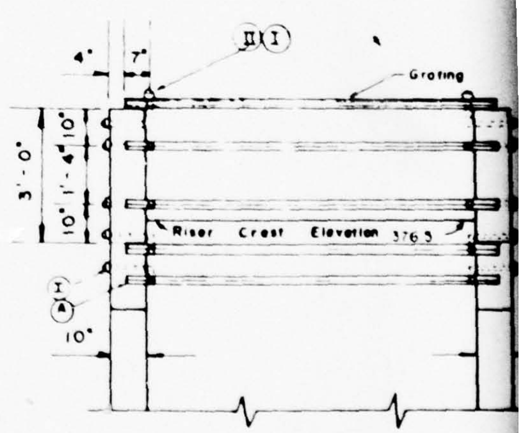
TOP - PLAN



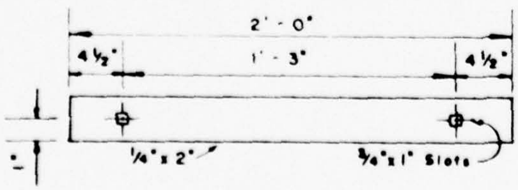
ISOMETRIC VIEW



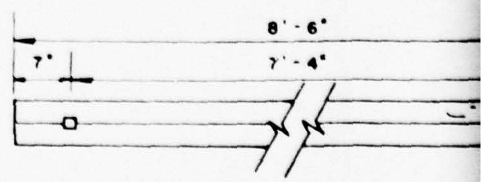
ENDWALL ELEVATION



SIDEWALL ELEVATION



STRAP

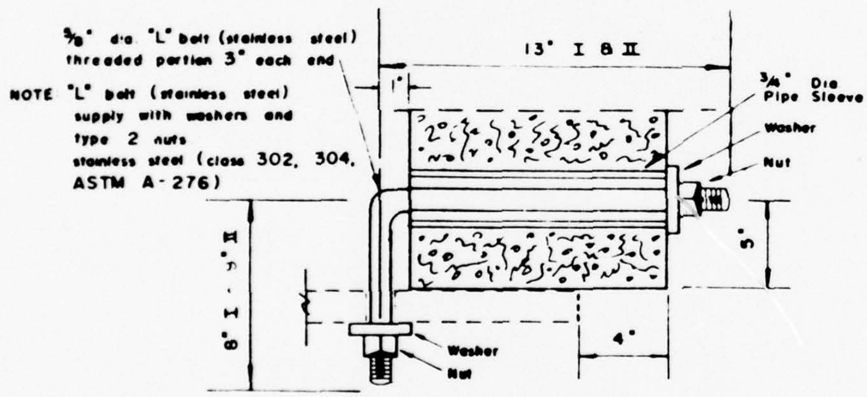


ANGLE A

TRASH RACK BILL OF MATERIALS			
ITEM	SIZE	LENGTH	QUANTITY
ANGLE (A)	2½"x2½"x⅜"	8'-6"	14
STRAP	¼"x 2"	2'-0"	2
"L" BOLT (stainless steel) I	⅝" DIA	13" x 8"	28
"L" BOLT (stainless steel) II	⅝" DIA	13" x 9"	4
GRATING PANEL	----	2'-0" x 8'-6"	1
SLEEVES	¾" DIA	10"	32

CONSTRUCTION DETAILS

1. Entire trash rack to be galvanized in accordance with Spec 582, except "L" bolts
2. Material in trash rack shall conform to Spec 581 for structural steel.
3. Grating shall be type W/B size No. 10 Borden or approved equivalent



BOLT DETAIL NO. 1

4'-6"

0"

7"

"X1" SLOTS

Not To Scale

"AS BUILT"

SEP 6 1973

30"

MOUNTAIN RUN SITE NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
HIGH STAGE TRASH RACK

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	C B CURRIN R W CRADDOCK	11/71
Drawn	A PALOTAI	7/71
	JFd E & WPU	1/72

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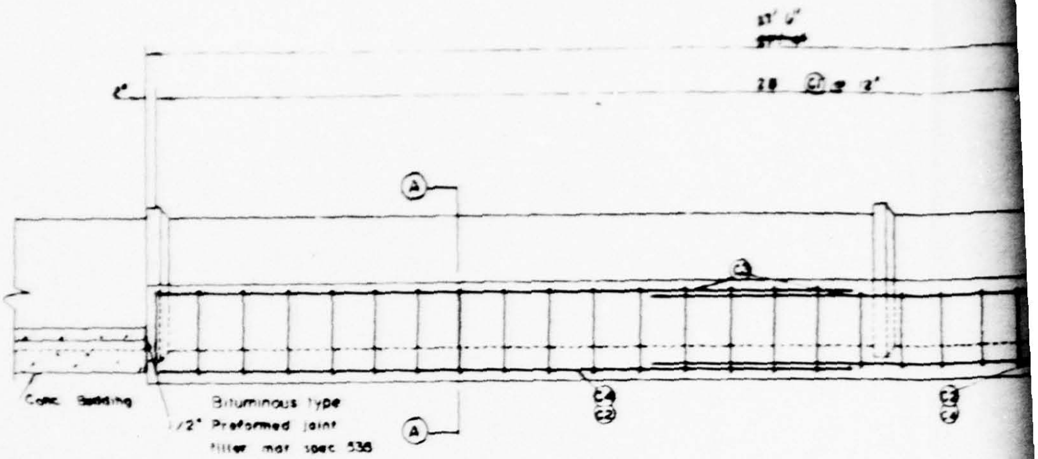
PLATE VII



REINFORCED CONCRETE CRADLE & BENT DETAILS

(NOT TO SCALE)

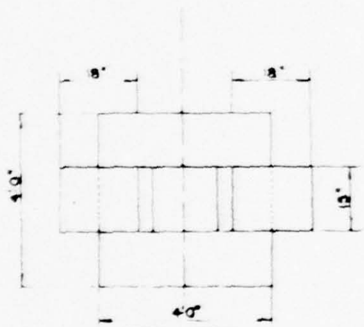
CLASS 4000 CONC

STEEL SCHEDULE									
MARK	LOCA-TION	SIZE	QUANTITY	LENGTH	TYPE	A	B	C	TOTAL FT
B1	BENT	3	4	3-0	T1	0-[illegible]	0-[illegible]	0-3	12-0
B2		4	[illegible]	3-6	T1	0-[illegible]	0-[illegible]	0-3	28-0
B3		4	2	4-3	1				8-6
B4		5	20	3-6	1				[illegible]
B5		7	4	9-6	21	[illegible]	1-0		38-0
B6	BENT	8	2	4-3	1				8-6
C1	CRADLE	3	28	7-[illegible]	3		1-[illegible]	0-[illegible]	219-[illegible]
C2		9	8	15-0	1				120-[illegible]
C3		6	4	14-[illegible]	1				58-[illegible]
C4	CRADLE	4	6	14-[illegible]	1				8[illegible]-0

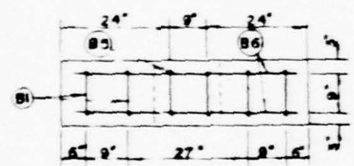
STEEL	LIN FT	LBS/FT	LBS
NO 3 Bars	231-4	0.376	87
NO 4 Bars	121-6	0.668	81
NO 5 Bars	70-0	1.043	73
NO 6 Bars	58-0	1.502	87
NO 7 Bars	38-0	2.044	78
NO 8 Bars	8-6	2.670	23
NO 9 Bars	120-[illegible]	3.400	408
Total weight			[illegible]37 LBS

CONCRETE, class 4000 reinforced (this sheet only)

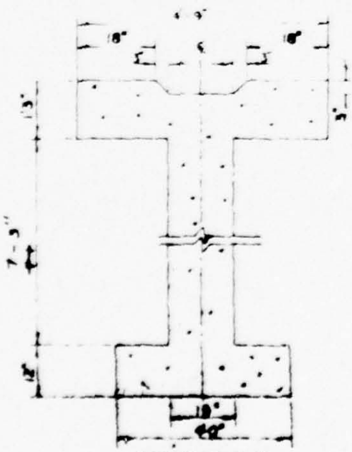
Bent 16
Cradle 61
Total 77 Cu Yds



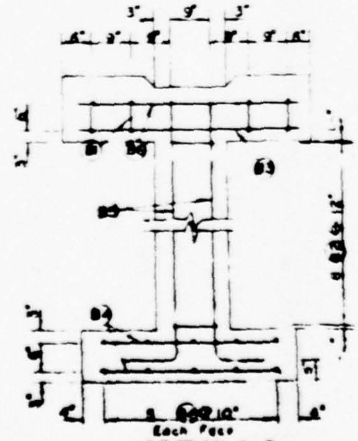
TOP VIEW



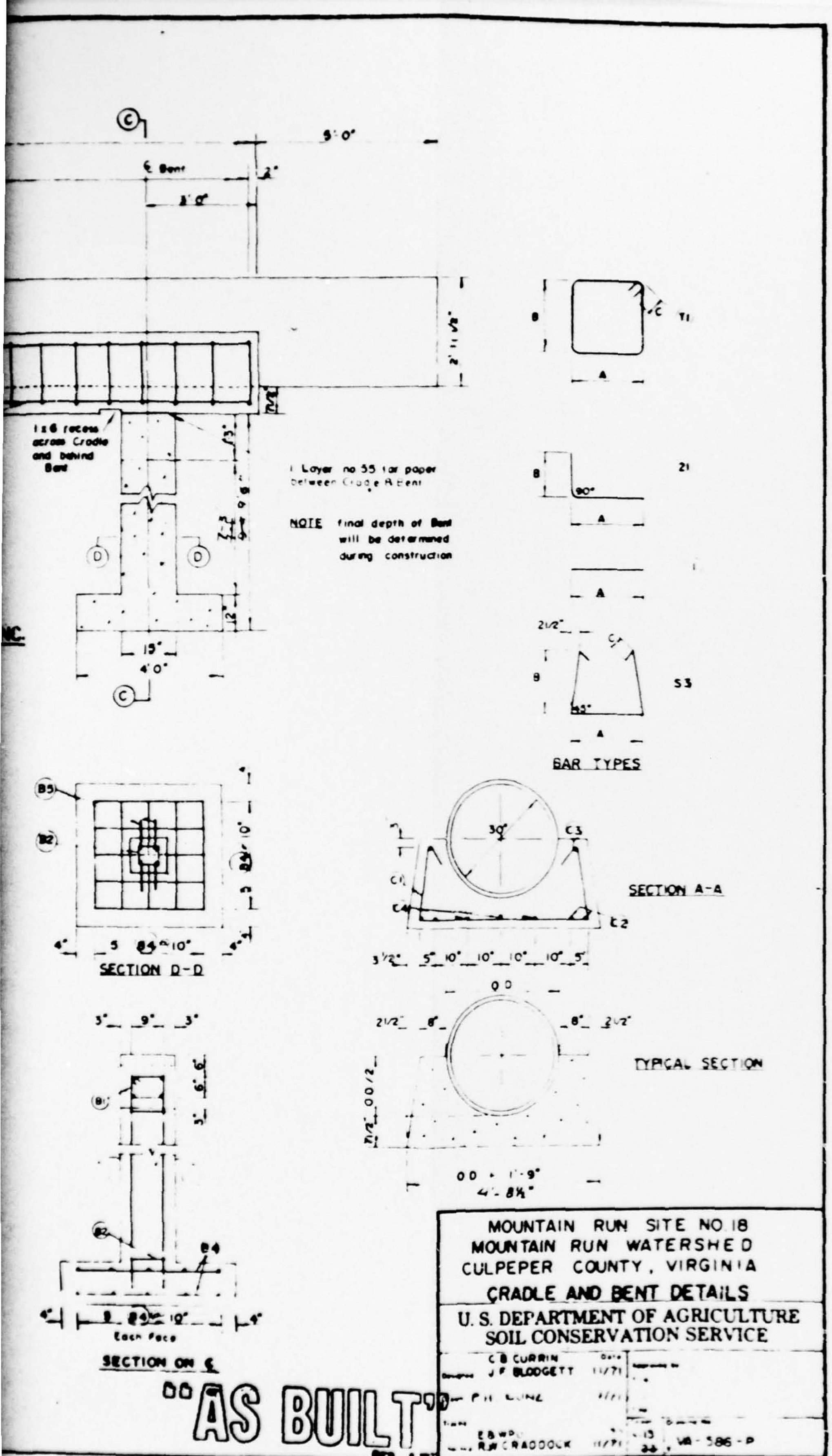
PLAN OF TOP SLAB



SECTION C-C



SECTION C-C


9'-0"
℄ Bent
2"
3'-0"
2'-11 1/2"
1x6 recess across Cradle and behind Bent
1 Layer no 55 tar paper between Cradle & Bent
NOTE final depth of Bent will be determined during construction
15"
4'-0"
T1
21
S3
BAR TYPES
B5
B2
4"
SECTION D-D
30"
C3
C1
C4
C2
SECTION A-A
3 1/2" 5" 10" 10" 10" 10" 5"
OD
2 1/2" 8" 8" 2 1/2"
TYPICAL SECTION
OD + 1'-9"
4'-8 1/2"
3" 9" 3"
B1
B2
B4
Each Face
SECTION ON ℄
"AS BUILT"
MOUNTAIN RUN SITE NO. 18
MOUNTAIN RUN WATERSHED
CULPEPER COUNTY, VIRGINIA
CRADLE AND BENT DETAILS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
C.B. CURRIN
J.F. BLODGETT 11/71
R.W. CRADDOCK 11/71
VA-586-P

2

PLATE VIII

VIEW FROM APPROACH CHANNEL OF EMERGENCY SPILLWAY

PLATE I

UPSTREAM

PLATE II

OUTLET WORKS

PLATE III

IMMEDIATE DOWNSTREAM AREA

PLATE IV

APPENDIX III

FIELD OBSERVATIONS

Name of Dam: Mountain Run Dam No. 18
County: Culpeper State: Virginia
Coordinates: Lat. 38°29'30" Long. 78°00'30"
Date of Inspection: 8 June 1978
Weather: Light rain - Temperature: 75°F
Pool Elevation at Time of Inspection: 376.5' m.s.l.
Tailwater at Time of Inspection: 360' m.s.l.

Inspection Personnel:

State Water Control Board
H. Wigglesworth

Corps of Engineers
W. Barker
L. Jones
D. Pezza (Recorder)
J. Robinson

1. Embankment:

1.1 Surface Cracks: The slopes, crest, and abutment contacts were inspected. The slope, and abutment contact were covered with 3 to 4 feet of light vegetation, making observations difficult. The vegetation was predominately grass, and an occasional small tree and bush were intermittently noted. The crest of the dam and downstream toe area was recently trimmed to 6 inches. Soil conditions were very moist due to wet weather conditions. No cracks were noted on the dam.

1.2 Unusual Movement: No unusual movement was noted on the dam. Again vegetation inhibited observations.

1.3 Sloughing or Erosion: Erosion of the upstream slope was noted at the waterline. The erosion was about 1 foot in height just above the present pool elevation. It was caused by either wavve action or pool fluctuation. Also, a portion of the reservoir embankment 20 feet upstream of the right abutment has eroded along the shoreline. At this point, a barbed wire fence parallel to the dam, extends 15 feet into the water. The portion in the water has been undermined and lays collapsed in the water. At the center of the upstream slope about three-quarters up, there is a 100 foot horizontal strip covered with thin growth of clover. The terrain in the area has evidence of very shallow (1 to 2 inches) gully type erosion. A few animal burrows up to 8 inches in diameter were noted. The crest of the dam has been used as a roadway. Although there are no ruts formed, the vehicular traffic caused bare spots which are desirable, as the crest of the dam must be protected with a good growth of grass. No sloughing was noted.

1.4 Alignment: The vertical and horizontal alignment of the dam did not deviate from the as built drawings. The crest of the dam serves as a dirt trail access road.

1.5 Riprap: The only riprap on the dam was in the discharge channel. Refer to section 2.3 for comments.

1.6 Junctions: The conditions appeared good. Observations were difficult due to high vegetative growth.

1.7 Seepage: No seepage was noted on the slopes at the abutments, along the toe or along conduits passing through the dam. The toe area right of the outlet works was not trimmed making observations difficult.

1.8 Drains: The structure has a toe foundation drain. Two 6 inch corrugated metal discharge pipes, serving the drain, were located on each side of the spillway conduit. The pipes were flowing less than one-sixth full and the water was clear. A rust colored colloidal sediment was noted in the bottom of the pipes.

1.9 Instrumentation: There were no instrumentation or staff gages for the entire dam.

2. Water Works:

2.1 Intake Structure: There was no access to the riser. The structure is concrete and showed no visible signs of deterioration. A vertical shaft, without manual controls for regulation of intake values, extended above the riser. The regulating works were not operated during the inspection. A trash rack, consisting of parallel angle-irons every 12 to 16 inches, covers the opening of the riser. No debris was lodged in the inlet nor was there any in the immediate area. Pool elevation was slightly higher than the drop inlet.

2.2 Outlet Works: A 30-inch ungated concrete conduit serves as the spillway running from the riser through the dam. The discharge end extended 15 feet beyond the toe of the dam. The last 5 feet of the conduit is cantilevered. The conduit was running about one-sixth full and showed no signs of deterioration.

2.3 Outlet Channel: A discharge channel extended approximately 50 feet from the toe of the embankment. The area behind and underneath the cantilevered conduit spillway was protected from eddy currents with diabased riprap. The riprap extended the full length of the outlet channel protecting the slopes and base of the channel. The riprap was built up across the end of the channel serving as baffles. The tailwater was approximately four feet below the conduit invert. Channel pools were measured up to 2 feet in depth and were deepest near the mouth of the conduit. Heavy vegetation has grown up through the rocks.

3. Emergency Spillway: The spillway is cut into existing terrain. The channel is in good condition and has excellent vegetative cover trimmed to 6 inches. The left cut slope was in excellent condition and was covered with 3 to 4 feet of light vegetation. The left dike was trimmed and also appeared in good condition. A trail access road traverses the approach channel and goes up the dike to the crest of the dam.

4. Reservoir: The area surrounding the upstream reservoir consists of gentle rolling hills covered with pasture land or planted fields. Two farms sitting on top of nearby hills are visible from the crest of the dam. No obvservations of sediment could be made. The water was clear and free from debris.

5. Downstream Channel: The channel immediately beyond the outlet channel had signs of erosion. The channel walls were 6 feet high with near vertical slopes. Above the channel the terrain was relatively flat. The stream narrows from approximately 20 to 5 feet about 200 feet downstream. No structures are in the apparent flood plane until the channel approaches the town of Culpepper, 0.75 miles downstream of the dam.

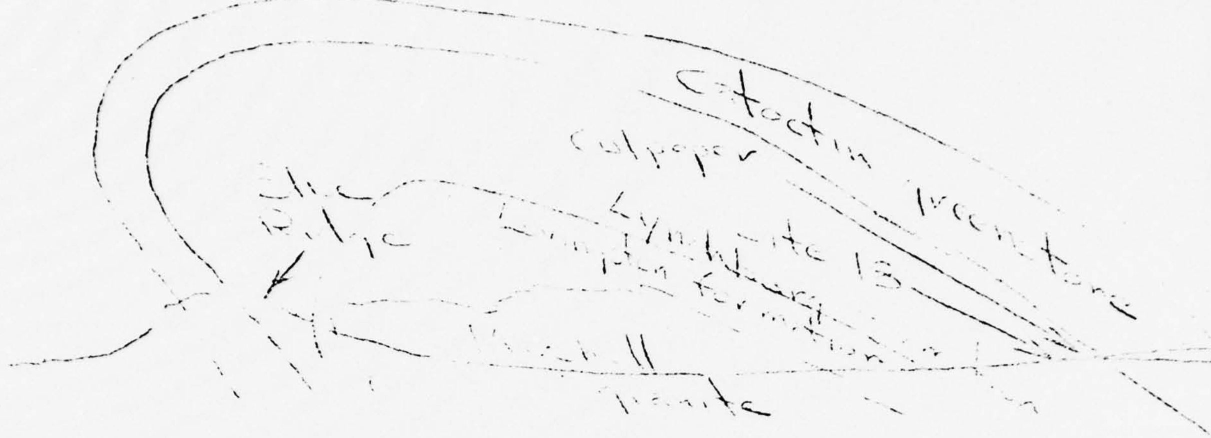
APPENDIX IV - GEOLOGY REPORT

#18

Geology

Sheet 2 of 10

(page 1 missing)



The Lynchburg Formation was deposited in late Precambrian time from sediments that came westward. These came from an old land-mass that occurred to the east of Richmond. The Lynchburg Formation is thick. A total thickness of 11,000 feet is a conservative estimate of thickness in this area.

petrology of the Lynchburg Formation is complex. Metamorphic rocks urring in this formation include mica gneiss, sericite phyllite, graphite rock, quartzite and sandstone, slate, meta-arkose, and meta-conglomerate. The metamorphic facies of this formation is below greenschist facies.

Metamorphic rocks of the Lynchburg Formation in the area of the dam are slate, phyllite, and meta-arkose, and amphibolite. These rocks are the metamorphic products of the following sediments as shown by the chart.

	heat and pressure	
slate	←	black shale
phyllite	←	acid shale
meta-arkose	←	arkosic sandstone
amphibolite	←	basic dike rock

The amphibolite is from basic swarm type dikes that fed the thick (approximately 12,000 foot) Catoctin lava flow. These dikes cross the Lynchburg Formation to a great extent. On Beautiful Run Watershed in Madison County where all dams are in the Lynchburg Formation, approximately 35 percent of the area is underlain by amphibolite dikes. These amphibolite dikes are the same age as the Catoctin greenstone. The r son they contain hornblende instead of the epidote minerals

in greenstone is due to higher metamorphic facies as:

$$\text{Basic lava} \xrightarrow{300^{\circ}\ c} \text{greenstone} \xrightarrow{600^{\circ}\ c} \text{amphibolite}$$

Igneous rocks occurring on the site are syenite and the pegmatite dikes that have the syenite stock as their origin. The syenite (granite without quartz) is the ridge - former that makes the steep right abutment. As the syenite shows little signs of metamorphism it could be correlated to the Mississippian age syenites and granites (such as the Leatherwood syenite, that fronts the face of the Federal Building in Richmond, Virginia) that are present in the western Virginia piedmont. The syenite occurring in the right abutment is fractured as observed on exposures occurring on the upstream side of the abutment.

A time table of geologic events that deposited, metamorphosed and fractured the rocks under Site No. 18 is given as:

Approximate Time	Period	Event
160 my	Triassic or Jurassic	Normal faulting
190 my	Permian	Formation of great anticline (folding)
220 my	Mississippian	Emplacement of syenite and pegmatite
520 my	Cambrian	Emplacement of amphibolite
650 my	Precambrian	Sedimentation of phyllite, slate and meta-arkose

Residual soil weathered from the diverse rocks of the Lynchburg Formation is present on the site. This residual material forms typical red-yellow podzols with a thick bright red B horizon overlying a sandy generally nonplastic micaceous C horizon.

Colluvial soils are almost non-existant in the area of the damsite.

Terrace soils are prominant in the area of this site. These include high terraces (Hiwassee series) intermediate terraces (Masada series) and low terraces (Augusta and Roanoke series).

These terraces were not implaced by the small stream at this site. They are rather the product of a former drainage system that flowed to the northeast as opposed to the prevalent southeastern drainage system in the modern Virginia piedmont.

Evidences of this former river system can be traced from stream gravels on hilltops and slopes from western Madison County through Culpeper County and out into the Culpeper Triassic basin.

Ball's Run flows in a strongly entrenched dendritic meandering course. At present the stream is slightly aggrading to neutral at the site.

METHODS AND PROCEDURES

1. The design engineer is kindly asked to bear with the above rather full description of the origin of rocks and soils occurring on this site. He is asked for a while to think "know why" of the scientist instead of thinking "know how" of the engineer.

Soils present on the site are classified both according to the Unified System and according to the U. S. Dept. of Agriculture System. Use of this latter system is made only as a fairly convenient grouping of total soil profiles into classes. The series names provide a convenient shorthand to express in two words what might otherwise take a phrase to express. The origins of the soil series are as follows:

Cecil Series = Deep residual, weathered from granite or syenite

Louisburg Series = Shallow residual weathered from granite or syenite.

Elioak Series = Deep residual weathered from phyllite, slate, gneiss, or meta-arkose of the Lynchburg Formation.

Hiwassee Series = High terrace with red un-mottled B horizon.

Masada Series = Intermediate terrace - yellow red with red and yellow fossil mottles.

Augusta Series = Fairly low terrace with clay - yellow and yellow red with brown and gray mottles.

Roanoke Series = Low terrace - light gray mottled with shades of yellow brown - poorly drained - tight.

ranges from 4.3 feet to 11.0 feet below the ground surface. Present in this soil are brown ML material and gray mottled ML, CL and SM lenses overlying a basal GM. This overlies up to 2.0 feet of weathered meta-arkose.

Talus of boulders and cobbles overlain by red brown colluvial silty sand (SM) is present at the toe of the slope of the right abutment from station 22+40 to station 23+15 on the dam centerline. This talus and colluvium ranges in thickness from 3.8 to 6.0 feet.

Residual soil weathered from syenite occurs on the right abutment from station 23+15 on the dam centerline to the top of the dam. This soil has 3.5 feet of yellow red hard silt (ML or MH) over 3.5 feet of weathered syenite.

To investigate the centerline of the dam 13 test pits were dug. These are numbered TP 2 through TP 14.

CENTERLINE OF THE PIPE

Two proposed pipes were investigated. These are designated as pipe "A" and pipe "B". The centerline of pipe "A" crosses the centerline of the dam at station 20+55 on the centerline of the dam and station 3+00 on the pipe centerline. These centerlines form a 78 degree 30 minute angle. The centerline of pipe "B" crosses the centerline of the dam at station 21+88 on dam centerline and station 3+00 on the pipe centerline. These centerlines are normal to each other.

The centerline of pipe "A" is placed on meta-arkose with injected amphibolite. The amphibolite is present between station 3+00 and 3+80 on the pipe centerline and downstream from station 4+15.

The alluvial soil that occurs on the centerline of pipe "A" has a layer of brown to red brown ML material overlying lenses of gray and mottled gray ML. CL and SM material that overlie a basal gravel (GM) layer. This soil is above weathered meta-arkose and amphibolite that ranges in thickness up to 6.3 feet.

The relief of the top of rock along this pipe centerline ranges from elevation 359.0 to elevation 351.0

The centerline of pipe "B" is placed on meta-arkose injected with syenite. The syenite occurs from station 3+25 to station 3+90 on this pipe centerline. This syenite is unweathered with backhoe refusal effected at 6.5 feet below the ground surface on unweathered syenite. The meta-arkose is weathered with up to 4.0 feet of weathered meta-arkose present.

Alluvial soil is present on the centerline of pipe "B" This alluvium has a top layer of from 0.5 to 3.0 feet of red brown to brown ML material overlying lenses of gray and mottled gray ML, CL. and SM material with a basal gravel above the weathered meta-arkose.

The relief of the top of rock on the centerline of pipe "B" ranges from elevation 358.0 to elevation 354.0

To investigate the centerlines of these two proposed pipes 21 test pits were dug. These TPs are numbered TP 301 through TP 310 (pipe "B") and TP 320 through TP 328 (pipe "A").

EMERGENCY SPILLWAY

The proposed emergency spillway cut is placed on the left abutment. The centerline of this emergency spillway crosses the centerline of the dam at station 13+10 on the centerline of the dam and station 5+65 on the centerline of the emergency spillway. The elevation of the level section which is placed downstream from the dam centerline is 386.9.

No rock was found to occur in the emergency spillway cut area.
(N[illegible] HOLES [illegible] 6[illegible])
Residual soil weathered from phyllite and slate (Elioak series) comprises the majority of the cut of the emergency spillway. This soil has from 2.5 to 5.5 feet of bright yellow red clayey silt (ML or MH) overlying up to 4 feet of red yellow silty sand (ML or SM). These layers overlie at least 15.0 feet of silty nonplastic micaceous sand (SM).

An area of high terrace soil (Hiwassee series) is present on the right side of the cut. This soil has 6.0 feet of yellow red, hard ML and CL with scattered gravels and GM. This overlies the olive gray, micaceous, nonplastic SM material weathered from phyllite. On the centerline of the emergency spillway this high terrace soil occurs from station 4+10 to station 7+35 with the majority of the terrace material present to the right of the EMS centerline.

From the entrance of the emergency spillway to station 3+00 on the centerline of the emergency spillway low terrace soil (Augusta series) occurs. This soil has 4.0 to 6.0 feet of clayey silt (MH, HL or CL) present overlying olive gray, nonplastic, micaceous, silty sand that has been weathered from phyllite.

To investigate the emergency spillway cut on the left abutment 15 test pits and hand auger holes were dug. These are numbered TP 250 through TA 264.

An alternate emergency spillway cut was investigated on the right abutment. As the hill on the right abutment forms a fairly narrow ridge at the top of the dam, the spillway cut will be shorter on this abutment However, hard, compact syenite rock occurs here. This rock has spines of syenite present. These spines range up to 4.0 feet of the ground surface or to elevation 399.0. Yet some of the test pits range up to 15.0 feet in depth or to elevation 392.0 feet without encountering syenite rock.

To investigate a possible emergency spillway cut on the right abutment 8 test pits were dug. These are numbered TP 201 through TP 208.

BORROW AREA

The borrow area is located upstream from the centerline of the dam in and around the edges of the permanent pool area. The borrow area extends 2,000 feet upstream from the centerline of the dam. It is approximately 700 feet in width and covers approximately 30 acres All of this land is cleared and at present is used as pasture land.

Terrace soils occur on the borders of the permanent pool. Above the right edge of the permanent pool terrace soil of the Masada series is present. This soil has hard, red with red yellow mottles, and gray mottled clayey silt, clayey sand and gravel that ranges in thickness from 13.5 feet to 5.6 feet. This soil overlays weathered mica phyllite and schist.

Low terrace soil of the Roanoke series occurs on the downstream part of the permanent pool area and above permanent pool elevation. This soil has from 6.5 to 8.0 feet of brown and gray mottled silt clay sand and gravel (ML, CL, SM and GC) overlying weathered phyllite.

Terrace soil of the Augusta series occurs in and above the upstream part of the permanent pool area. This soil has from 3.5 to 5.0 feet of brown, yellow and gray silt, clay and gravel ML, CL and GC over weathered phyllite, meta-arkose and slate.

Recent alluvium occurs in the central portion of the borrow area. This is in the floodplain. This alluvium has from 7.0 to 8.0 feet of brown and gray silt, clay, sand and gravel (ML, CL, SM and GM). The basal gravel is loose and wet. The soil overlies weathered phyllite. The water table present in April 1969 ranges from 4.5 to 7.5 feet in depth.

To investigate the borrow area 30 test pits were dug. These are numbered TP 101 through TP 130.

3
VA 586-G

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES
Supplemental
GENERAL

State Virginia County Culpeper ¼ ¼ Sec. T. R. Watershed Mountain Run

Subwatershed Ball's Run Fund class 08 Site number 18 Site group 1 Structure class C

Investigated by (Signature and title) Equipment used (Type, size, make, model, etc.) Date

SITE DATA

Drainage area 3.53 sq. mi. 2259 acres Type of structure Earth fill Purpose Flood control and water supply

Direction of valley trend downstream southeast Maximum height of fill 34.4 Length of fill feet

Estimated volume of compacted fill required 28,000 cu. yds.

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	156	31.3	13.0
Floodwater	1500	122	[illegible]
Water supply	270	46.0	16.5

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Piedmont Province Topography gently rolling Attitude of XXX Schistosity Dip 48°E 35°E Strike N42°E N47°E

Steepness of abutments: Left 06.3 percent Right 32.5 percent Width of floodplain at centerline of dam 350 feet

~~XXXXXXXXX~~ Methods and Procedures

1. The centerline of the dam was moved from the paper centerline presented in the 35's by a surveying error. This newest centerline will be the centerline to be used in final design. This is because the drill holes are located on this last line. This final centerline forms the fourth centerline placed on this one site. These four centerlines are listed in chronological order as follows:

a. The planning party centerline

b. The centerline incorrectly surveyed on the planning party centerline

c. The paper centerline on the 35's laid in 75 feet upstream and parallel to the second centerline - This paper centerline was emplaced to position the cutoff and core upstream from the narrow right abutment.

d. The centerline surveyed in to place the drill holes on the third centerline. Unfortunately these last two centerlines do not coincide.

In the 35's, all test pits are located on the third centerline. In final design, all test pits and drill holes are located from the fourth centerline.

Foundation material occurring in the drill holes is correlated to the samples taken in the test pits. No samples were shipped for analysis from the drill holes.

2. Standard equipment was used in taking the blow count, the permeability tests, and the pressure tests.

Permeability values were taken into the rock. This was done by subtracting the preceding gpm value from the gpm value obtained. This gives the actual gpm for the run.

Centerline of the Dam

Nine drill holes were emplaced on the centerline of the dam in the foundation area.

These drill holes showed soil conditions to approximate those soil conditions described in the first draft of the centerline of the dam.

On the left side of the stream valley these soil conditions are alluvial and terrace soil overlying C horizon soil weathered from phyllite and slate with weathered meta-arkose, phyllite, and slate.

The drill holes show that the weathered meta-arkose, phyllite, and slate are underlain by syenite at depths of 25 to 34 feet.

The weathered metamorphic rock could be drilled with a roller bit with blow counts ranging from 10 to greater than 50 blows per foot.

Syenite occurs on the right side of the flood plain. Here it is present at the top of the rock with no metamorphics below the soil layer.

On the right abutment this syenite is weathered.

At station 22+00 on the dam centerline a fault is present between the syenite and the meta-arkose. This fault contains a running sand that pushed up into the casing in DH 37. The top of this fault zone was at 15.0 foot depth in DH 37.

This must be a fairly high angle fault since no fault was encountered in DH 37C which is 7.0 feet away from DH 37.

Fractured syenite is present below a depth of 25.1 feet in DH 39 at station 17+51 on the dam centerline. This fractured rock has water passing through it. This water below 31.5 feet depth gives a water gain of 0.304 gpm at the casing collar.

The foundation has an average of slightly permeable. K factors range from near zero to less than 4.0 ft./day. The majority of K factors present here are below 1.0 ft./day.

The drill holes placed on the centerline of the dam are numbered DH 31 through DH 39.

Centerline of the Pipe

The centerline of the proposed pipe crosses the centerline of the dam station 20+55 on the dam centerline and station 3+00 on the pipe centerline. As the centerline for final design was moved from the 35's centerline, the angle between these two lines will be given in design. This is to insure that the pipe is aligned with the stream channel.

Soil conditions on the centerline of the pipe approximate those previously discussed. These show an alluvial soil over C horizon and weathered meta-arkose with some amphibolite dikes.

DH 331 at station 1+89 on the proposed pipe centerline shows weathered phyllite and meta-arkose to extend to a depth of at least 38.0 feet. At 35.0 feet a high blow count is obtained. This drill hole was the only drill hole emplaced on the pipe centerline. It is near the riser location.

Emergency Spillway

One drill hole, DH 231, was placed in the proposed emergency spillway cut. This hole showed soil to be present to a depth of 26.5 feet. A low blow count was obtained just above this 26.5 foot depth.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS 376C
REV. 2-64
SHEET ____ OF ____

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
Mountain Run	Ball's Run	Culpeper Co.	Virginia

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
18	I	C	Linsday Mack	4/70

For In-Service Use Only

INTERPRETATIONS AND CONCLUSIONS

1. The cut-off should be extended to backhoe refusal on rock in the floodplain below the permanent pool level. On the left abutment above permanent pool elevation the cut-off should be extended at least 2.0 feet into weathered phyllite and amphibolite. On the right abutment the cut-off should be extended to the shallow top or rock present here.

With the emplacement of this cut-off there should not be excessive water passing under the foundation. No thrust faults are considered to be present. Jointing and minor Triassic normal faulting are, however, considered to be present. A likely place for this normal Triassic age faulting to occur is on the contact of the syenite and the meta-arkose and phyllite. This is due to the difference in the shear strength of the hard syenite (approximately 6 on the Moh scale) and the relatively softer meta-arkose and phyllite (approximately 3 to 5 on the Moh scale). Thus, when tension force is applied, normal faulting occurs at the juncture of the harder and softer rocks. Also, a suspicious factor for normal faulting here is the fact that the edge of the syenite underlying the foundation area forms a 90° angle. The downstream edge of the contact of this syenite and the metamorphics form a 45° angle with the perpendicular to the strike of the Culpeper Triassic basin. As all igneous plutonic rocks are considered to have a maximum shear angle (Phi angle) of 45° even in contact with weaker rocks, this appears to show that a 90° normal faulting pattern occurs on the edge of the syenite as it lays in contact with the meta-arkose and phyllite.

This Triassic age (or perhaps Jurassic age) faulting pattern could be related to an obvious displacement of the border of the Triassic basin to the eastward approximately three tenths of a mile downstream from the dam centerline.

However, for a flood control dam that has only an eight foot deep permanent pool, these small normal faults are not considered dangerous. Some flood control dams have been emplaced with known normal faults occurring in the area with little effect on the water holding capacity of the abutments.

A proximate example in the Lynchburg formation is Beautiful Run No. 5. Here this worker pointed out to the inspector (Mr. Henry Aylor) a thrilling example of a normal fault on the right abutment of the site that passed through the inside edge of the emergency spillway. In fact, the right angle normal fault pattern in the Beautiful Run area of the Lynchburg formation is so pronounced that Beautiful Run flows in a

stream pattern that approaches a trellis pattern as opposed to the prevailing entrenched dendritic flow to the southeast.

The Beautiful Run sites all hold water, demonstrating the soundness of the abutments. Other Virginia sites where known normal faults were observed during investigation also have abutments that hold water.

This consideration of normal faulting to an out-of-state worker may indeed sound callous. However, an expression told to this worker by a geologist in this state should be considered. This expression is: "The more I work on dam foundations in Virginia, the more I am convinced there is a normal fault running up every stream valley in the state."

But there are factors present in Virginia that will place a dam in severe jeopardy of failure. These are factors such as thrust faults, sink holes, and narrow fractured abutments.

2. In regard to the last danger of narrow fractured abutments, the right abutment has present fractured syenite. As this abutment is narrow the water must be stopped before reaching the fractured syenite. With this in mind, the centerline of the dam was moved 15 feet upstream from the original centerline. Care should be taken by the designer to secure a good cut-off upstream from the fractured syenite. Also, the core must be maintained upstream from the rock with appropriate zoning between the core and rock.

3. A toe or seepage drain should be considered. This drain will be placed upstream from the majority of the amphibolite dike.

In the Lynchburg formation an amphibolite dike tends to form a solid wall beneath a structure. This is because fracturing forces tend to batter up the softer phyllite and slate and not to fracture the amphibolite. Thus, to some extent the amphibolite dike acts as a buttress to prevent water from passing out from under the downstream toe of the dam.

4. Two proposed pipe centerlines are presented. Each centerline is acceptable for placement of the pipe. Each has its slight merits and disadvantages.

Pipe centerline A presents a shorter outfall channel and the better alignment with Ball's Run. It will be easier to move the concrete for the cradle to this centerline. This centerline forms a 78° and 30' angle with the dam centerline.

Pipe centerline B forms a 90° angle with the dam centerline. It will have a longer outfall channel. It will also be slightly harder to move the concrete trucks to this area. But generally, location B is considered to be the better due to the 90° angle with the dam centerline.

With the invert held at elevation 361.5, both centerlines present no rock removal problems.

Removal of all alluvium (ML, CL, SM and CM) down to the weathered rock should be considered in both centerlines. Compaction of a tight clay cushion of CL or ML material would form a solid base for the pipe above the weathered rock.

5. The alluvial and terrace materials present in the foundation are considered to have sufficient strength to bear the weight of to 32.4 foot high structure.

6. The left abutment was chosen as the proposed location of the emergency spillway cut. In the soil weathered from phyllite here no rock was found with either the backhoe or the hand auger. Even if weathered phyllite or slate rock are found to occur in the cut, both these rocks have proven to be rippable. The clay B horizons of e Elioak, Hiwassee and Augusta series are suggested to be placed in the core in the soil correlation chart. The micaceous sandy nonplastic C horizon of the Elioak series which underlies all areas of the cut ranges up to a depth of 20.0 feet in the proposed cut. This should give a slightly greater proportion of nonplastic shell material (over 2/3 of the total cut material) than needed in the structure. This can be adjusted by using the plastic CL and ML material of the borrow area for core. From preliminary estimates some of this SM from the emergency spillway cut will have to be wasted as it will make surplus shell material for the embankment.

If attention is given to the placement of the emergency spillway in the right abutment. it is considered that much of the syenite removed here will have to be classed as rock removal. The syenite spines occurring here are hard to impossible to rip. Also, since this granite-like rock occurs in spines. some spines can be present that were not found with the backhoe.

It is estimated that at least 2,300 yards of rock will have to be removed from the emergency spillway out on this abutment.

The placement of the emergency spillway in the right abutment will mean a shorter spillway since the right abutment is fairly narrow. Also, the B horizon (DS 203-1) of residual soil weathered from syenite should more plastic than the B horizon (DS 250-1 and DS 256-1) of soil athered from phyllite.

(Could also use flatter grade on ES inlet section & not excavate so much SM)

[illegible] 3/4/[illegible]

7. Sufficient borrow is considered to be available to construct the embankment. It is suggested that all of the edges of the permanent pool be cut down at least 2.5 feet on a 3 to 1 slope If this is not done there will be swamping conditions around the edges of the permanent pool. The CL and ML material taken in this removal can be used as core material in the embankment.

In the isopach map the bogging down of heavy pans will occur before the water table is reached. Thus, the recoverable borrow from the alluvial soil will be less than shown on the isopach map.

The highly plastic CL material of the Roanoke series will be hard to remove with a pan. This plastic soil material tends to stick to the floor and gates of the pan. Often many contractors have been unable to move this soil from the borrow area to the embankment.

However, the time of year will determine the workability of this plastic material of the Roanoke series. In a wet winter and spring this clay will be sticky and hard to handle. In the dry summer and autumn this clay will prove to be hard and tight. Local residents call this clay a "half-past" soil. For in the morning at half past eight it is too sticky to plow and at half past nine in the morning it is too hard and dry to plow.

Cutting into the abutments near the dam on the right side of the floodplain should yield a deep high terrace soil (Masada series) that should not be excessively plastic.

Suggested placement of the borrow materials is given in the soil correlation chart.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS 376C
REV. 2-64
SHEET 1 OF 2

VA 586-G

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED		SUBWATERSHED	COUNTY	STATE	
Mountain Run		Ball's Run	Culpeper County	Virginia	
SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)		DATE
18	1	c			10/71

Supplemental
INTERPRETATIONS AND CONCLUSIONS

FOR IN-SERVICE USE ONLY

1. Depth of cutoff should be extended into the weathered phyllite and meta-arkose on the left side of the stream valley. This should be to a depth with a blow count of approximately 40 blows/foot. This will mean a cutoff trench of approximately 15.0 feet in depth on the left side of the stream valley.

On the right abutment the cutoff could be carried to a depth of 15.0 feet. Below this depth there is a blow count greater than 70 blows/foot.

2. Permeability and pressure tests in the drill holes on the centerline of the dam showed K factors to be low.

However, several places are present in the foundation that could be subject to passing water through the foundation.

Among these is the normal fault occurring in DH 37 at station 21+94 on the dam centerline. This fault appears to have a running sand present. It does not appear to be excessively permeable (K = 3.51 ft/day). but pipeable

Also to be considered is the fractured meta-arkose and syenite in DH 39 at station 17+51 on the dam centerline. Below a depth of 21.5 feet this rock passes a small amount of water. Pressure is sufficient to force the water out of the casing. The rock was too fractured to pressure test.

Although fairly deeply weathered, the right abutment shows slight to slightly moderate water loss.

364.0 [illegible]

3. With the invert of the pipe held at elevation 361.5 there will be no rock removal problem on the proposed pipe.

The riser will be placed on soft 10 blow/foot CL material with weathered phyllite and meta-arkose below. This weathered material is soft with a range of from 10 to 40 blows/foot. Support for the heavy riser structure in this weathered rock is to be considered.

4. The low blow counts obtained near the ground surface should be considered as to the settling of the embankment.

5. A drill hole (DH 231) was taken to below grade in the proposed emergency spillway cut. A low blow count at the bottom of this hole shows the weathered phyllite and slate present is soft.

APPENDIX V - STABILITY ANALYSIS SUMMARY

1. Referring to Appendix VI, the conditions used for stability analysis and the results by the Swedish circle method were as follows:

Width of crest: 12.4 feet
Elevation of crest: El. 395.9 ft.
Downstream slope: 1 vert. on 2½ horiz.
Upstream slope: 1 vert. on 2½ horiz.
Embankment base elevation: El. 359.5 ft.
Elevation of emergency spillway crest: El. 386.9 ft.
Seepage drain at c/b = 0.5
Soil data:

Material	Classification	Dry unit wt. pcf	wet unit wt. pcf	sat. unit wt. pcf	sub. unit wt. pcf	Ø degree	C psf
Embankment	ML	95.7	114.0	124.0	61.5	30.0	800
Foundation	-	-	-	-	-	-	-

Loading condition: Pool level at emergency spillway crest.
Factor of safety of trial failure surface:
Upstream slope under full drawdown = 2.57
Downstream slope under steady seepage = 3.12.

2. Referring to Appendix VI, the conditions used for stability analysis and the results by the sliding block method were as follows:

Width of crest: 14 feet
Elevation of crest: El. 395.9 ft.
Downstream slope: 1 vert. on 2½ horiz. to toe at El. 363
Upstream slope: 1 vert. on 2½ horiz. to El. 374.0
1 vert. on 10 horiz. to El. 373.0
1 vert. on 3 horiz. to El. 363.0
Foundation base elevation: El. 359 ft.
Elevation of emergency spillway crest: El. 386.9 ft.
Seepage drain at c/b = 0.6
Soil data:

Material	Classification	Dry unit wt. pcf	wet unit wt. pcf	sat. unit wt. pcf	sub. unit wt. pcf	Ø degree	C psf
Embankment	ML	95.7	114.0	124.0	61.5	30.0	800
Foundation	ML	79.9	-	113.0	50.5	21.0	300

Loading condition: Pool level at emergency spillway crest.
Factor of safety of trial failure surface:
  Upstream slope under full drawdown = 2.25
  Downstream slope under steady seepage = 2.27.

APPENDIX VI - DESIGN REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory
800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Virginia WP-05, Mountain Run Site #10 (Culpeper County)

DATE: August 12, 1970

TO: Louis S. Button, Jr., State Conservation Engineer
SCS, Richmond, Virginia

(Mr. Nelson rec'd copy)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 5 sheets.
2. Form SCS-128, Consolidation Test Data, 6 sheets.
3. Form SCS-355, Triaxial Shear Test Data, 3 sheets.
4. Form SCS-366, Direct Shear Test Data, 1 sheet.
5. Form SCS-352, Compaction and Penetration Resistance, 10 sheets.
6. Form SCS-357, Summary - Slope Stability Analysis, 3 sheets.
7. Form SCS-130, Drain Materials Test Data, 1 sheet.

DISCUSSION

FOUNDATION

A. Classification. In the floodplain, 4 to 11 feet of alluvial CL, ML, SC, SP-SM, and GP-GM materials blanket meta-arkose and amphibolite bedrock. The meta-arkose bedrock is weathered in the surface two feet of the floodplain.

In the left abutment, 4 to 8 feet of residual silty soil blankets from 4 to 6 feet of weathered phyllite and slate bedrock.

In the steep right abutment, 3 to 5 feet of silty residual soil blankets several feet of weathered syenite bedrock. At the toe of the slope, 3 to 6 feet of talus boulders and cobbles and silty sand have accumulated.

B. Dry Unit Weight. The "gallon" can undisturbed samples, which were taken in February, were received at the lab in May. The paraffin used to seal some of the cans was cracked and the samples were dried out. Shrinkage caused by drying appears to have caused a density increase in the moderately plastic CL materials.

A wide range of dry densities was obtained from the undisturbed samples submitted to the laboratory. The dry densities of the alluvium ranged from 1.00 gm/cc for the MH sample, 70W1820 (11.1)

B. Compacted Dry Density. Standard Proctor compaction tests (ASTM D-698, Method A) were made on ten of the borrow samples submitted to the laboratory. Maximum dry densities varied from 88.0 pcf for the MH sample, 70W1823 (203.1), to 114.0 pcf for the SM sample, 70W1832 (109.1). Optimum moisture contents ranged from 32.5% to 13.5% respectively.

C. Shear Strength. A consolidated undrained triaxial shear test was made on the non-plastic ML sample, 70W1828 (257.1). The test specimens were molded to 95% of standard density with moisture contents near optimum and then soaked for seven days to saturate. Some swelling occurred during soaking, causing a slight loss in density. Average density of the 1.4-inch diameter specimens when tested was 93.4% of standard density. The average moisture content of the test specimens was 92.5% of theoretical saturation. The shear test data was interpreted to give total stress shear parameters of $\phi = 30°$ and $c = 800$ psf.

The more plastic ML and CL materials at 95% of standard density are expected to have as good or better strength in the proposed 32-foot high embankment than the ML sample that was tested.

D. Consolidation. Average embankment settlement in the 30-foot high floodplain section is estimated to be approximately 0.5 feet.

STABILITY ANALYSIS

The proposed 36-foot high maximum section was analyzed using a modified Swedish circle method of analysis. The 33-foot high floodplain section over four feet of foundation was analyzed using a sliding block method. Shear parameters of $\phi = 30°$ and $c = 800$ psf were used in the embankment and $\phi = 21°$ and $c = 300$ psf were used in the foundation. A safety factor of 2.25 was obtained for a full drawdown analysis of the 2 1/2:1 over 3:1 upstream slope with a 10-foot berm at elevation 373.0. The downstream 2 1/2:1 slope with a drain at c/b = 0.6 yielded a safety factor of 2.27.

SETTLEMENT ANALYSIS

The bedrock of the steep right abutment has a slope of approximately 2 1/2 horizontal to 1 vertical. Average settlement of the fill and foundation at the abutment is estimated at 1 1/2%. Differential settlement for a consolidation potential of 1 1/2% against a 2 1/2:1 slope was calculated to be 0.006 ft/ft. The moderately plastic ML and CL core materials are expected to take that amount of uniform differential settlement without cracking.

from 4.5 to 5.5-foot depth at dam ¢ station 17+51 to 1.88 gm/cc for the sandy SC sample, 70W1815 (322.1) from station 3+68 of principal spillway ¢ pipe A. Most of the shallow alluvial ML samples had dry densities in the range of 1.35 to 1.38 gm/cc.

C. Consolidation. One-dimensional consolidation tests were made on the low density ML sample, 70W1812 (305.2) and a dense specimen of the CL sample, 70W1818 (326.1).

The test specimens were loaded at their existing moisture content (which was quite dry) to 4000 psf and then were saturated under the 4000 psf loading. The low density ML sample gave an immediate consolidation of 4% when saturated under a 4000 psf load. Total consolidation potential of the ML sample under the 4300 psf load of the proposed 35-foot high dam was 5%. The moderately plastic CL sample yielded a consolidation potential of approximately 1% under a 4300 psf load.

D. Shear Strength. Consolidated undrained triaxial shear tests were made on the low density alluvial ML sample, 70W1812 (305.2) and the more dense alluvial CL sample, 70W1818 (326.1). A direct shear test was made on the sandy SP-SM sample, 70W1816 (322.2).

Dry density of the triaxial shear test specimens of the ML sample, 70W1812 (305.2) varied from 1.26 gm/cc to 1.33 gm/cc. The test specimens were soaked for seven days to saturate and were 78 to 80% of theoretical saturation when tested. The shear test data was interpreted to yield total stress values of $\phi = 21°$ and c = 300 psf.

Dry density of the CL test specimens of sample 70W1818 (326.1) varied from 1.58 gm/cc to 1.64 gm/cc. The test specimens were soaked for seven days to saturate and were 92 to 100% of theoretical saturation when tested. The shear test data was interpreted to give total stress shear parameters of $\phi = 20.5°$ and c = 1250 psf.

The 2 x 2-inch SP-SM direct shear test specimens were flooded at the start of loading. Dry densities varied from 1.49 gm/cc to 1.62 gm/cc. The direct shear test data was interpreted to give shear parameters of $\phi = 34.5°$ and c = 1000 psf.

EMBANKMENT

A. Classification. The borrow materials will consist of mostly silty sand, like the non-plastic ML sample, 70W1828 (257.1) from the emergency spillway, and moderately plastic silty terrace soils, like the ML sample, 70W1833 (110.1) from the borrow area. Small amounts of SC, SM, and CL materials will also be available.

Some "collapse" potential was noted in the consolidation test of the dry ML sample, 70W1812 (305.2). This is a "normal" result when low density silty materials are loaded in a dry state and then saturated. The drill logs list the shallow alluvium as moist and the water table is shallow, so it is doubtful that the dry foundation condition exists. Uneven wetting of dry low density silty foundation materials could cause embankment cracking.

RECOMMENDATIONS

A. Centerline Cutoff. For foundation alluvium with over 18% moisture a normal width cutoff with 1:1 side slopes extending to firm bedrock is recommended below the permanent pool elevation. Backfill with moderately plastic ML or CL materials placed at or above optimum moisture content and compact to a minimum density of 95% of standard.

If the floodplain foundation alluvium is dry, the foundation should either be pre-wet before construction starts or the dry low density silty material should be removed.

B. Drainage. A foundation trench drain at c/b = 0.6 is recommended to outlet possible seepage that bypasses the centerline cutoff through the bedrock, and to control the phreatic line in the embankment. A two-layer filter is suggested to drain the wide range of foundation materials. ASTM fine concrete aggregate around ASTM road aggregate #78 will be sufficient. See the attached Form SCS-130 for gradation of materials.

C. Principal Spillway. Pipe elongation calculations based on 35 feet of embankment (B = 204') over six feet of compressible foundation with a 5% consolidation potential show a horizontal strain of approximately 0.002 ft/ft. A minimum of undercutting to establish grade is suggested to avoid logitudinal strains along the principal spillway trench. The alluvium on each side of the principal spillway will control the spreading in the base of the embankment.

Backfill with moderately plastic fine-grained materials placed on the wet side of optimum and compact to 95% of standard density.

D. Embankment Design. The following are recommended:

1. Selectively place the plastic CL and ML borrow materials in the

John A. Geter
Subj: Virginia WP-03, Mountain Run Site #18

center section for an impervious core. Place at or above optimum to obtain the lowest permeability.

2. Selectively place the micaceous non-plastic ML and SM materials in the outer shells.

3. Compact embankment to a minimum density of 95% of standard.

4. Provide 2 1/2:1 over 3:1 upstream slopes and 2 1/2:1 downstream slopes.

5. Provide an overfill of 0.6 foot across the floodplain to compensate for residual foundation and embankment settlement.

Prepared by:

Edgar F. Steele

Reviewed and Approved by:

Lorn P. Dunnigan
Head
Soil Mechanics Laboratory

Attachments

cc:
Louis S. Button, Jr. (orig. + 5)
Neil F. Bogner, Head, E&WPU, Upper Darby, Pa. (2)

MATERIALS TESTING REPORT | U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE: POCKET RUN SITE 1F VIRGINIA

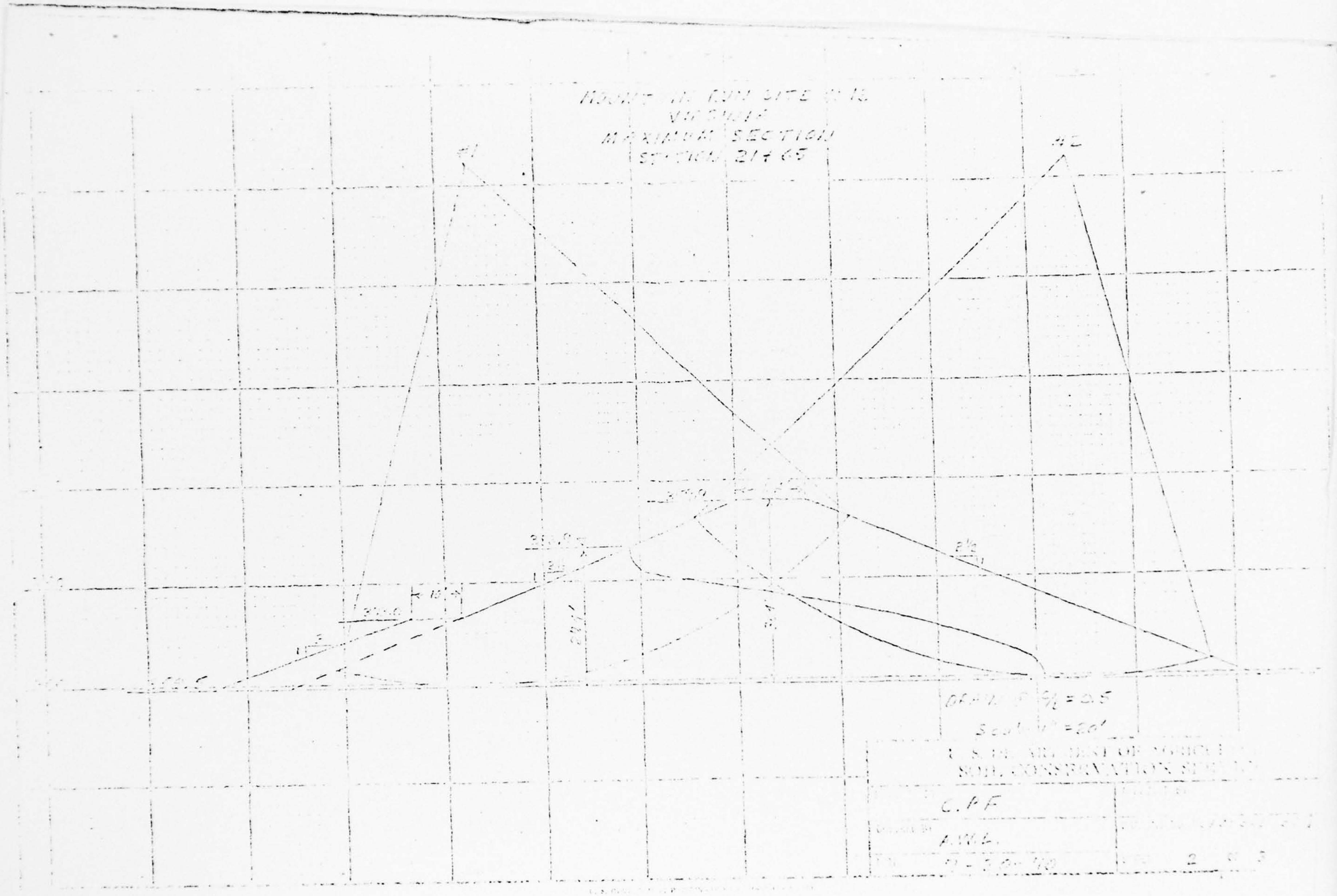
METHOD OF ANALYSIS: SWEDISH CIRCLE & WEDGE

ANALYZED AT: SKL LINCOLN NEB.

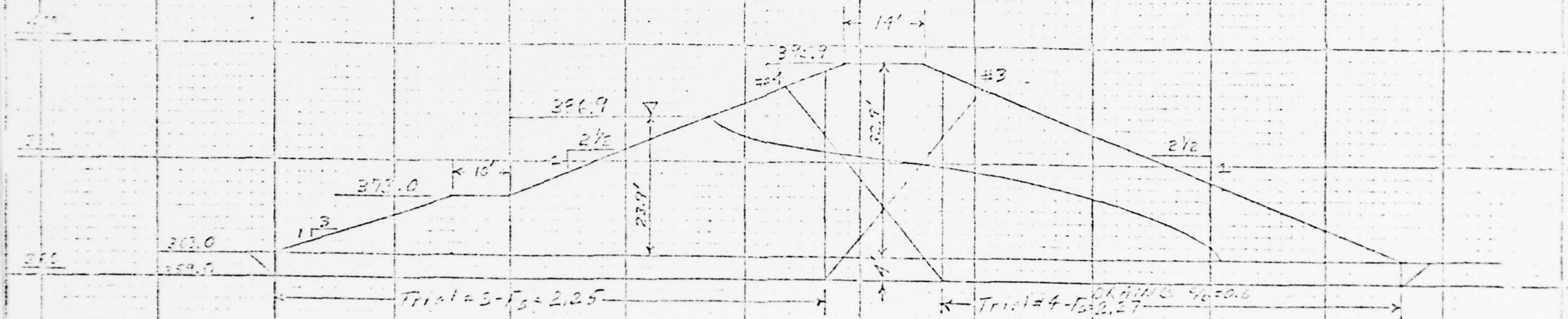
APPROVED BY:

SOURCE AND USE OF MATERIALS	CLASSIFICATION	Yd (pcf)	Ym (pcf)	Ysat (pcf)	Ysub (pcf)	φ (deg)	tan φ	c (psf)	REMARKS
① FOUNDATION	ML	79.9	—	113.0	50.5	21.0	.384	300	
② FOUNDATION	CL	100.5	—	126.0	63.5	20.5	.358	1250	
③ FOUNDATION	SC-SM	98.0	—	123.5	61.0	34.5	.687	1000	
④ EMBANKMENT	ML	95.7	114.0	126.0	61.5	30.0	.577	800	
⑤									
⑥									
⑦									
⑧									

TRIAL NO.	SLOPE	CONDITIONS	F_s
		Maximum Section @ Station 21+65	
1 UP	2½:1	FULL DRAWDOWN, NO BERM, ARC CUT THROUGH EMB. (30°-800)	2.57
2 DN	2½:1	STEADY SEEPAGE, NO BERM, DRAIN @ %b=0.5, ARC CUT THROUGH EMB. (30°-800)	3.12
		Flood Plain Section @ Station 21+00	
3 UP	[illegible]	FULL DRAWDOWN, 10' BERM @ ELEV. 373.0, WEDGE CUT THROUGH EMB. (30°-800) AND 1' FOUND. (21°-300)	2.25
4 DN	2½:1	STEADY SEEPAGE, NO BERM, DRAIN @ %b=0.6, WEDGE CUT THROUGH EMB. (30°-800) AND 1' FOUND. (21°-300)	2.21


MAXIMUM SECTION
21+65
#1
#2
C.P.F
A.W.L.

MOUNTAIN RUN SITE 11
VIRGINIA
FLOOD PLAIN SECTION @ STA. 21+00



Scale: 1" = 20'

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DESIGNED BY C P F	APPROVED BY
CHECKED BY A.W.L	DRAWING NO. F.XM SEC-35-7
DATE 7-20-73	SHEET 3 OF 3

APPENDIX VII - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Dept. of Army, Office of the Chief of Engineers.

2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation.